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# The Effects of Exercise on Acute Energy Balance and Macronutrient Intake

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To the Graduate Council:

I am submitting herewith a thesis written by Emily N. Jokisch entitled "The Effects of Exercise on Acute Energy Balance and Macronutrient Intake." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Hollie A. Raynor, Major Professor

We have read this thesis and recommend its acceptance:

Dixie L. Thompson, Jay Whelan, Hollie A. Raynor

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Jay Whelan

Dixie Thompson

Accepted for the Council:

Carolyn R. Hodges
Vice Provost and Dean of the Graduate School

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# The Effects of Exercise on Acute Energy and Macronutrient Intake

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Emily Jokisch

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**Abstract**

This investigation examined acute energy compensation and macronutrient intake in habitually active and sedentary, college-aged males, following an exercise session as compared to a resting (control) session, to see if habitually active males compensate intake better to an energy deficit incurred by exercise, than sedentary males.

Participants were males, aged 18-30 years, of a normal percent body fat and body mass index, and exercised $\leq$ 60 min per week (sedentary) or $\geq$ 150 min per week (habitually active). Participants came in for two sessions: 1) 45 minutes of resting (control) and then eating an *ad libitum* meal; and 2) riding a cycle ergometer for 45 minutes (exercise) and then eating an *ad libitum* meal. Sessions were counterbalanced across participants. Energy and macronutrient intake were calculated for the meal and over the remaining part of the day.

Sedentary individuals ate significantly less during the meal in the exercise session (which expended a mean of 453.5 kcals across both groups) as compared to the control session (934.8 $\pm$ 222.0 kcals vs. 1073.9 $\pm$ 470.3 kcals, $p < 0.03$), which demonstrated negative energy compensation (-30.6%). The habitually active group showed no significant difference in energy intake between sessions at the meal (1016.8 $\pm$ 396.7 kcal [control] vs. 1105.6 $\pm$ 389.2 kcal [exercise]). While the habitually active group showed no significant difference in intake at the meal, the slight increase in intake at the meal in the exercise session demonstrated some energy compensation (19.6%), which was significantly better ($p < 0.03$) than that in the sedentary group. No differences in macronutrient intake at the meal were found between the sessions. Over the day following the sessions, both groups reported a significant increase in energy intake after the exercise session as compared to the control session (1457.5 $\pm$ 646.2 kcals vs. 1356.1 $\pm$ 657.2 kcals, $p < 0.04$), with no difference in macronutrient intake between the sessions.

These results indicate that, although complete acute compensation did not occur, the habitually active group acutely compensated intake significantly more so than the sedentary group, demonstrating better energy regulation ability.

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# Introduction

The United States is in the midst of experiencing an obesity epidemic (1). In the years 2003-2004 the rates for overweight and obesity were 32.2% and 31.1%, respectively. Since overweight and obesity trends are on the rise, it is likely that this cause of positive energy balance is not only due to an increase in food intake, but also to a decrease in the amount of activity people are getting throughout the day. This lack of activity may not only contribute to a decrease in energy expenditure but may also contribute to poor energy regulation capabilities, leading to positive energy balance, and consequential overweight and obesity (3).

In the 1950's, Jean Mayer proposed a theory regarding the biological regulation of energy balance, in which there was a central regulatory system that was capable of closely matching energy intake to energy expenditure, and that this system worked with variations in the energy expenditure of an organism to appropriately guide what was consumed (3).

Recent experimental human research regarding the acute effects of exercise on food intake does suggest that normal weight individuals who engage in regular physical activity may more appropriately regulate intake as compared to sedentary normal weight and overweight individuals (7, 8, 9, 10, 11). Research with individuals who are habitually active has found that in general energy intake is increased in a meal consumed one hour after a single bout of exercise as compared to a meal consumed one hour after no bout of exercise (7). When the acute effect of exercise on food intake is examined in sedentary, normal and overweight participants, intake in a meal consumed 60 minutes following a single bout of exercise is generally not increased as compared to a control session with no exercise, indicating poor energy compensation (8, 9, 10, 11). Other studies investigating the effects of increasing activity in previously sedentary individuals have found improvements in energy compensation capabilities after regularly engaging in exercise. This indicates that increasing regular physical activity over time may improve compensation abilities, and thus energy regulation, in individuals (12, 13).

Previous investigations indicate that there may be a difference in energy regulation, and thereby energy compensation, between individuals who have a history of engaging in regular and consistent exercise versus sedentary individuals who do not have this history. Currently, no research has been conducted testing acute energy compensation capabilities to exercise in active versus sedentary individuals who are of a healthy weight. Therefore, the purpose of this investigation was to examine acute energy compensation and macronutrient intake in habitually active and sedentary, healthy, normal weight (BMI of 20-24.9 $kg/m^2$), unrestrained, college-aged males following exercise.

# **Chapter 1:**

## **Abstract**

In the years 2003-2004 the rates for overweight and obesity were 32.2% and 31.1%, respectively, making overweight and obesity trends are on the rise. It is likely that this cause of positive energy balance is not only due to an increase in food intake, but also to a decrease in the amount of activity people are getting throughout the day. This lack of activity may contribute to poor energy regulation capabilities, leading to positive energy balance, and consequential overweight and obesity (3).

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Recent experimental human research regarding the acute effects of exercise on food intake does suggest that normal weight individuals who engage in regular physical activity may more appropriately regulate intake as compared to sedentary normal weight and overweight individuals (7, 8, 9, 10, 11). Other studies investigating the effects of increasing activity in previously sedentary individuals have found improvements in energy compensation capabilities after regularly engaging in exercise. This indicates that increasing regular physical activity over time may improve compensation abilities, and thus energy regulation, in individuals (12, 13).

Currently, however, no research has been conducted testing acute energy compensation capabilities to exercise in active versus sedentary individuals who are of a healthy weight. Therefore, the purpose of this investigation was to examine acute energy compensation and

macronutrient intake in habitually active and sedentary, healthy, normal weight (BMI of 20-24.9 kg/m$^2$), unrestrained, college-aged males following exercise.

**Background and Significance:**

Introduction

The United States is in the midst of experiencing an obesity epidemic (1). In the years 2003-2004, the rates for overweight and obesity were 32.2% and 31.1%, respectively. This is a significant difference from data collected for the National Health and Nutrition Examination Survey (NHANES) in 1999-2000, where overweight and obesity was 31.5% and 30.5%, respectively. Currently, the prevalence of overweight and obesity is over 60% in the United States (1). Overweight and obesity is a consequence of positive energy balance, where more energy is taken in through food than is expended. Since overweight and obesity trends are on the rise, it is likely that this cause of positive energy balance is not only a consequence of an increase in food intake, but also a consequence of a decrease in the amount of activity achieved throughout the day. According to the Centers for Disease Control and Prevention (CDC), in 2007 only 48.8% of adults engaged in physical activity for 5 or more days per week for at least 30 minutes, which is the current recommendation for overall good health (2). Moreover, 37.7% of adults engaged in more than 10 minutes per week of activity but less than the recommended amount, and 13.5% of adults had less than 10 minutes per week of activity (2). In addition to this, 24.1% of adults had no leisure-time physical activity (2). This lack of consistent physical activity may not only contribute to a decrease in energy expenditure but may also contribute to poor energy regulation capabilities in humans (3).

In the 1950's, Jean Mayer was the first nutrition scientist to develop a theory regarding the biological regulation of energy balance (3). This theory proposed that there is a powerful and complex central regulatory system that is capable of closely matching energy intake to energy expenditure, and that this system works with variations in the energy expenditure of an organism and the nutritional value of the diet consumed (3). Mayer's research revolved around what happens when the balance of energy input and energy output is disrupted and a state of positive energy balance develops (3). Mayer's research led him to believe that while there are many important components to the regulation of energy balance, one highly prominent component was energy expenditure via physical activity level (PAL). He proposed that regulation of food intake does not function equally well at all levels of PAL, but is especially poor at low levels of PAL (3). Figure 1, found in Appendix A, demonstrates Mayer's theory regarding PAL and energy regulation, in which food intake is only appropriate for needs in the range of "normal activity" (3).

Mayer proposed that individuals with low levels of physical activity are least able to regulate energy balance, and intake is often greater than expenditure, resulting in a state of positive energy balance (3). As obesity has become an ever-growing problem in the United States (1) and as the amount of physical activity engaged in by most individuals in the United States has decreased (2), many researchers have begun to experimentally test Mayer's theory of energy balance regulation to better understand factors that may be influencing the current obesity epidemic. Conceptually, this theory proposes that if high levels of physical activity improve energy-regulation capabilities, then individuals who regularly engage in physical activity should compensate intake appropriately after performing activity of different intensities and/or time lengths. That is, they consume more following activities that expend more energy as compared to activities that expend less energy. Furthermore, this theory would also conclude that sedentary individuals would not compensate after performing activity of different intensities and/or time lengths, meaning that regularly inactive people would consume the same amount of energy with or without exercise done prior to eating. Since Americans as a whole are fairly inactive, this inactivity may be contributing to overall poor energy regulation capabilities.

Energy systems and activity

All energy in the human body is derived from the breakdown of complex nutrients such as carbohydrates, fats, and proteins. During physical activity, there is a balance between utilization of carbohydrate and fat, known as the "crossover" effect, where the nutrient used varies and depends on the duration and intensity of the activity (4). The crossover point is the power output at which energy from carbohydrate-derived fuels predominates over energy from lipids. When exercising is engaged in at low intensities (<45% VO2max), lipid is the main substrate used for energy. Conversely, during higher-intensity exercise (>70% VO2max), carbohydrate is the main substrate used for energy. During exercise training and workouts, most individuals are at ~70% VO2max, thus they are mainly dependent on carbohydrate as a fuel source. However, lipid does become the main fuel source during recovery from exercise, as a result of glycogen depletion (4).

When the macronutrients (substrates) are utilized for energy, the production of adenosine triphosphate (ATP), the energy currency of the body, occurs. ATP provides all the energy for the biochemical processes of the body. There are various pathways that produce ATP during exercise, and the pathway in use depends on the type, duration, and intensity of the exercise. The high energy phosphagen system is used for short duration activities of high intensity. The anaerobic glycolytic system is used for short to moderate duration activities of higher intensity.

Lastly, the aerobic oxidative system is used for longer duration activities of low to moderate intensity (5). The diagram of these processes is shown in Figure 2 in Appendix A (5).

The high-energy phosphate system can provide energy for muscles in the initial 1 to 15 seconds of high-intensity activity. The primary energy sources for this pathway are ATP and phosphocreatine (PCr). The initial stages of high-intensity exercise cause ATP to be broken down through the enzyme creatine kinase to supply inorganic phosphate for ATP resynthesis. This high-energy phosphate system can supply energy until the intramuscular stores of ATP are decreased and after that, for as long as there is a supply of PCr to resythesize ATP. Unfortunately these stores are small, and are depleted rapidly in high-intensity work (5). Therefore another system is needed to provide energy when the activity will be sustained longer.

Anaerobic glycolysis is the primary energy system that is used to perform intensive exercise that is greater than 12 to 15 seconds and less than 3 minutes in duration. Energy production for glycolysis is done in the cytoplasm of skeletal muscle by the catabolism of carbohydrate, in the form of glucose or muscle glycogen, which goes on to form pyruvate. This process releases energy in the form of ATP, which is then used for muscle contraction. This process is done through a series of enzymes which breakdown glucose in the absence of oxygen. This system is not very efficient and only forms 2 mols of ATP for each mol of glucose that is broken down. Most of the energy from this system is dissipated as heat. Furthermore, when the work rate is high, the ending molecule pyruvate can accumulate faster than the next pathway (aerobic oxidation system) can process, and pyruvate will then be converted to lactic acid (5). Therefore, in longer exercise duration, to prevent the buildup of lactic acid, the body looks to utilize another system.

Exercise that is performed at an intensity lower than that of anaerobic threshold relies exclusively on the aerobic system for energy production. Also, if the duration of an intensive activity increases, the relative contribution of the aerobic oxidative system to total energy production increases. The aerobic energy system depends on three main things: that the working muscles have sufficient mitochondria to meet energy requirements, that sufficient oxygen is supplied to the mitochondria, and the enzymes or intermediate products do not limit the rate of energy through the Krebs Cycle and respiratory chain. The Krebs cycle and the respiratory chain are the bioenergic pathways that produce ATP in the mitochondria for energy for the muscles (5).

Through these processes, energy from substrates is used for exercise and the energy needed for these pathways is what causes a person to burn calories during exercise. For example, during exercise that would be typically done to lose or maintain weight, such as running or biking at a moderate speed for a longer duration of time, a person would reduce their glycogen stores for energy. Therefore, the macronutrient they would most need to take in would be carbohydrate to restore these glycogen stores. Another example would be after weight training or lifting, a person has broken down muscle, and would need to take in the macronutrient protein to help repair that muscle tissue. Since the majority of exercise utilizes glycogen stores, the majority of substrate intake during exercise should be from carbohydrates.

<u>The beginning research: Jean Mayer</u>

During the time of Jean Mayer's research in the 1950's, it was generally assumed that "the relationship of food intake to exercise was one of direct proportionality above the basal level corresponding to inactivity" (pg 544 – 6). In other words, that animals would increase their food intake directly proportional to the amount of energy they expended through exercise. Jean Mayer found that this was not always the case.

In a study done with sedentary, obese rats (6), Mayer exercised rats on a treadmill for varying periods of time from 20 minutes to 60 minutes and all the way up to 6 or 7 hours. He then looked to see how much the rats would consume after exercise, to see if they truly did compensate energy intake to match energy expenditure. Mayer found that for exercise times up to an hour, the rats did not increase the amount of food they consumed. In fact, he actually found that there was a small decrease in their intake. However, above an hour of exercise, the food intake increased in direct proportion with energy expended from exercise. He saw this effect up to 6 hours of exercise, when most rats reached exhaustion. Mayer then realized that since there was an initial drop in energy intake corresponding to exercise energy expenditure there was not a true increase in food intake above initial amount until 2 hours of exercise. This study showed that a certain amount of physical activity in sedentary rats is possible without a corresponding increase in caloric intake. Mayer stated that these sedentary, obese rats may have greater availability of reserves for energy, and therefore may not need to take in the energy until they exercised for more than an hour. Studies done previously in Mayer's lab (7, 8) also found what they called a "sedentary range," where they observed that there was a point that existed where a large decrease in activity was not accompanied by a corresponding decrease in food intake, but there was actually a slight increase in food intake, resulting in positive energy balance and further obesity. These findings seem to point to an idea that overweight and/or sedentary animals may have a decrease in energy regulation abilities because the energy regulatory system may not be sensitive to changes in energy expenditure.

Mayer wanted to extend the findings that had been observed with animals and test the concept of energy regulation in humans. Thus he and colleagues (9) examined 213 Bengalian men who were employed in various types of jobs, with differing levels of energy expenditure associated with the jobs. From these various jobs, Mayer estimated energy expenditure done daily for each job and placed them into 5 different groups: sedentary, light work, medium work, heavy work, and very heavy work. Participants completed extensive dietary interviews and physical demand surveys to assess energy intake and energy expenditure. Results indicated that the sedentary group consumed a higher amount of calories, even though they were expending the least amount of energy. The light work group actually had a slight decrease in calories as compared to their energy expenditure. Lastly, the medium work through the very heavy work groups had increasing energy intake corresponding directly with their amount of energy expended. These findings were similar to what had been found with the animal studies. In both cases, Mayer found that food intake increases with activity only in a certain zone. This showed that depending on normal activity levels, there is a corresponding difference in energy intake. Also, when looking at sedentary participants, a lack of compensation occurred demonstrating that there was no reduction in energy intake when there was a reduction in energy expended (9).

Jean Mayer tested his theory regarding the relationship between PAL and energy compensation in humans using an observational approach. This type of study design makes it difficult to draw conclusions, as observational designs do not show a cause and effect relationship between the independent variable (PAL) and the dependent variable (energy intake). Cause and effect can only be shown in an experimental design, where the level of energy expenditure through PAL can be measured and manipulated, and exact energy intake can be assessed. This allows an objective comparison between energy expenditure from activity and energy intake, enabling a measure of compensation to occur. Thus, one way to study energy regulation capabilities using an experimental approach is to examine the acute influence of exercise on energy intake within a laboratory setting where energy expenditure and intake can be objectively measured.

The influence of exercise on consumption: Acute trials with regularly active participants

Research studies that look at the acute effects of exercise on energy intake generally have participants attend multiple sessions in which they engage in activity for varying amounts of time and measure their consumption in an *ad libitum* meal after the exercise. Usually, so that the act of engaging in physical activity itself does not affect hunger, there is a time period of rest between performing the exercise and consuming the *ad libitum* meal. Assuming the rest of the variables in the study are consistent, this method allows the researchers to see if compensation occurs to the differing amounts of energy expenditure incurred from the varying amount of exercise.

A study conducted by Pomerleau et al. (10) looked at the effects of different exercise intensities on food intake and appetite in moderately active women. Participants in this investigation were 13 women, aged 18 to 30 years, were not pregnant, free of disease and food allergies, weight stable with an average body mass index (BMI) of 22.2 $kg/m^2$, and moderately active. They defined moderately active as 30-45 minutes of continuous exercise performed 3-5 times per week. For the experimental design of this study, they looked at different exercise intensities and the participants' energy compensation following exercise at a lunch buffet and over the course of the day. The three different types of experimental sessions were a high-intensity session, a low-intensity session, and a control session where they sat and read for the same duration as the exercise sessions. The low-intensity exercise consisted of 40% of oxygen uptake and the high intensity exercise consisted of 70% of oxygen uptake, and both exercise sessions were designed to be equivalent in terms of total energy expended of 350 kilocalories. Participants were randomized to different sequence orders. For each experimental session, participants were asked to come in the morning for a standardized breakfast, and then completed one of the experimental protocols. The experimenters then served a buffet type meal one hour after the session, but were asked to come back for dinner and were allowed to bring home snacks, and told to keep track of food eaten throughout the day. The results from this study showed that energy intake was significantly higher at lunchtime after the high intensity exercise compared to the control session. The daily energy intake was also higher after the high intensity exercise as well, but was not statistically significant. Researchers also examined the post-exercise energy intake corrected for the energy cost of exercise above the resting level, termed relative energy intake (REI). For REI, a significant difference between the control session and the two exercise sessions was found after lunch, but there was no difference across sessions when looking at the whole day, showing proper compensation. These results showed that individuals, who engaged in a habitual exercise program, tended to appropriately compensate intake after increasing exercise so that a negative energy deficit did not occur.

In a study conducted by King et al. (11), the effects of exercise on the suppression of appetite and food intake were examined. The participants for this study were healthy males, aged 21 to 27 years, who had a mean BMI of 24.2 kg/m$^2$. The participants in this study participated in at least three hours of physical activity per week, were not taking any form of medication, and were of sound mental and physical health. These individuals were subjected to three different exercise trials; one at high intensity, one at low intensity, and one control where they were at rest for the same time period. The high-intensity exercise consisted of cycling at 70% of their VO2 max for approximately 30 minutes. The low-intensity exercise consisted of cycling at 30% of their VO2 max for approximately 60 minutes. Both of these exercise regimens allowed for the total energy expenditure to remain fairly similar with the low-intensity exercise expending 389 kcal and the high-intensity exercise expending 340 kcal. Lastly, the resting component consisted of participants seated and were allowed to read or write quietly for 45 minutes. Fifteen minutes after each trial the participants were allowed to eat *ad libitum* consisting of four different foods (sandwich, strawberry yogurt, fruit cocktail, and plain biscuit). Throughout the sessions, researchers measured participant's motivation to eat and hunger ratings through visual analog scales (VAS) given to the participants immediately before and after breakfast and lunch, as well as before, during, and immediately after the exercise or rest sessions. The results showed that hunger ratings decreased during and immediately after the high-intensity exercise. They also found that there was no significant difference in energy or macronutrient intake between the three test sessions. The results demonstrate the existence of a temporary suppression of appetite, as reflected in the reduction in hunger during and directly after exercise. However, in terms of energy regulation, these participants showed no statistical difference in intake from the exercise trials to the control trials. It was proposed that the lack of improper compensation was a consequence of the measure of intake given too soon after exercise. This outcome highlights an important methodological issue, as hunger may be suppressed during and immediately following exercise, and only later (i.e., 60 minutes and longer) may proper compensation occur, as hunger begins to increase.

<u>The influence of exercise on consumption: Acute trials with sedentary participants</u>

Other studies have looked at different levels of physical activity, both high- and low-intensity, in non-active individuals, and the acute influence of the level of activity on energy intake. The results from these studies are varied, but the majority show that intake is not increased after high-intensity exercise (12). This indicates that individuals who are not habitually active have poor energy regulation, since at higher levels of exercise intensity in which more energy is expended compensation should occur to maintain energy balance. For example, Moore et al. (13) examined energy intake in sedentary girls, BMI > 25 $kg/m^2$, aged nine and ten years, after a trial of high-intensity exercise, low-intensity exercise, and a control trial. The exercise sessions consisted of a heart rate corresponding to 50% of peak oxygen for the low-intensity exercise session, and 75% of peak oxygen for the high-intensity exercise, both resulting in an almost equal amount of energy expenditure. The low-intensity exercise session resulted in 4.06 MJ of energy expenditure and the high-intensity session resulted in 4.36 MJ. After each trial they were allowed to eat *ad libitum* from a supplied buffet one hour after each exercise session. The researchers found that the *ad libitum* meal energy intake was similar in the control and exercise conditions. This study shows that in children who are not habitually active and overweight, poor energy compensation occurs. Thus, amount consumed at meals is most likely consistent with habitual intake, rather than responsive to energy balance (13).

Similarly, a study examining sedentary adults investigated acute energy and macronutrient compensation following exercise. A study conducted by Klausen et al. (14) compared males and females by age (categorized into younger and older age groups) and looked at energy and macronutrient intake after exercise. The participants were healthy, non-athletes, not regularly exercising with no history of metabolic disorders, with a mean BMI of 22.5 $kg/m^2$. The researchers had participants come into a lab setting for three days, engage in activity at different intensity levels, and then measured their energy and macronutrient intake. The high-intensity exercise consisted of thirty minutes at 60% of their VO2 max, and the low-intensity exercise consisted of sixty minutes at 30% of their VO2 max. The researchers did not state whether the energy expenditures from these two exercise intensities amounted to the same amount. Following each exercise session, participants stayed in the laboratory for an hour and then were given an *ad libitum* meal. The rest of the day, participants self-recorded food intake at home. The results from this study showed no compensation in energy intake for the greater amount of expended energy in the high-intensity session than the low-intensity session, but they did find an increase in fat intake after the high-intensity session. This could potentially show that in participants who do not regularly engage in regular exercise, energy compensation does not occur, but that fat intake may be elevated following activity.

A study by Harris and George (15) looked at sedentary males who were of normal weight (BMI of 20 to 24.9 kg/$m^2$) or overweight (BMI of 25 to 29.9 kg/$m^2$) and compared their energy intake after one exercise and after one resting session. Participants were placed into one of five groups: 1) normal weight, low restraint, non-dieting; 2) normal weight, high restraint, non-dieting; 3) overweight, low restraint, non-dieting; 4) overweight, high restraint, non-dieting; and 5) overweight, high restraint, dieting. Participants came into the study having eaten a typical breakfast and walked on the treadmill at 60-65% of max heart rate for 60 minutes, or for the resting session they sat quietly for the 60 minutes. After the 60 minute session, the participant walked to the cafeteria where they chose a meal and ate *ad libitum* about 15 minutes after the session. After the participants ate, the excess food on the plate was measured and energy intake was measured. The researchers also measured 12 hour post exercise energy intake by conducting a dietary recall by telephone the day after each experimental session. The results from this study showed that weight, level of dietary restraint, dieting status, and condition did not significantly influence lunch or 12 hour post-exercise energy intake. However, there were significant results when calories were averaged across exercise and resting conditions, where among overweight participants, dieters had a significantly lower lunch post-exercise energy intake than non-dieters. The results of this study are in contrast to many of the findings from previous studies but there are many factors that may have played a part in this. Some of these factors are the length of time between the exercise and eating and the "food court style of the cafeteria." Also this study examined dieting and restraint as potential factors, as these factors may influence a person's innate drive to eat through psychological factors.

A study conducted by Martins et al. (16) specifically examined physiological factors, such as gut peptides, that may influence energy and macronutrient intake following physical activity. In this study, 12 healthy men and women between the ages of 23 and 28 years, had a mean BMI of 22 $kg/m^2$, who did not have a physical or mental disease, were not on medications, did not smoke, and did not have an active lifestyle, were studied. For this investigation participants came in and ate a controlled breakfast and then cycled for an hour at 65% of their maximal heart rate or they completed an experimental session in which they rested. Both of these sessions were completed in a randomized order for each of the participants in the study. After this, participants were provided with a buffet type meal and were told to eat *ad libitum* one hour after exercise. Twenty-four hour dietary recalls were collected to examine habitual intake, and blood was collected at regular intervals throughout the study day. The results showed non-esterfied fatty acids (NEFA) and plasma triacylglycerol (TAG) became elevated during exercise. Peptide YY (PYY), glucagon like peptide-1 (GLP-1), and pancreatic polypeptide (PP) all increased during exercise and this increase remained post-exercise for GLP-1 and PP. The results also showed that hunger scores were decreased during exercise but increased post-exercise or within one hour after exercise. There was a significant increase in energy intake after exercise, but still a lower relative energy intake as compared to what was expended, so complete compensation did not occur. No difference in macronutrient intake from the meal was found.

<u>The influence of exercise on consumption: The effect of increasing activity in sedentary individuals</u>

Interestingly, increasing regular physical activity in previously sedentary individuals may improve energy compensation abilities (17). Martins et al. (17) examined short term appetite control after a 6-week exercise program in previously sedentary individuals. Participants consisted of 25 sedentary individuals, 11 males and 14 females, who had a mean age of 29.8 years and a BMI of 22.7 $kg/m^2$ and were not currently dieting to lose weight. Participants were measured at baseline for fitness and metabolic data. Participants started a 6-week exercise program which consisted of exercising 4 times per week for 30 to 40 minutes at 65-75% of their maximum heart rate. Subjective hunger and fullness were assessed throughout the study using VAS. To measure differences in energy compensation capabilities at baseline, participants were asked to come in on two different days to participate in a preload challenge, where they were given a high-energy preload or a low-energy preload, one on each day, with the sessions scheduled at least two days apart. Sixty minutes after the preload the participants were given a buffet meal and asked to eat *ad libitum*. With this type of measure, better energy compensation abilities occur when intake in the meal is greater following the low- as compared to the high-energy preload. Researchers repeated the preload challenge at the end of the 6-week exercise program. Results from this study found that with the preload challenge, there was an improvement in compensation abilities over time. These results suggest that training with exercise may have a significant impact of short-term appetite control by leading to more sensitive energy compensation capabilities.

Another study conducted by Whybrow et al. (18) looked at different amounts of exercise over a 14 day period and its effects on energy intake. The researchers recruited 6 lean men and 6 lean women between 18 and 40 years of age, who were considered sedentary or had a moderately active lifestyle (these criteria were not defined in the study). For this study, the participants came in for three different conditions, no added exercise, moderate exercise, or high exercise, with each condition lasting 16 days. For each condition, in the first two days participants were given a standardized energy and macronutrient diet that served as a baseline, no exercise occurred. On days 3 through 16, the participants went through one of the three conditions. No added exercise consisted of maintaining their usual day-to-day activities. Moderate exercise consisted of completing two 40 minute sessions per day to expend 28.6 kJ/kg. High exercise consisted of completing three 40 minutes sessions per day to expend 57.1 kJ/kg. Each condition was separated by at least one week. The results from this study showed that average daily energy expenditure increased across conditions for both men and women. Average daily energy intake did not change significantly as exercise increased in women, but it did in men. Macronutrient intake did not significantly change over conditions for men or women. It was shown, on average, that participants compensated for approximately 30% of the exercise-induced energy deficit, but this number varied among individuals and compensation was significantly higher among males than among females. As discussed in previous studies, there may be a greater correspondence between energy expenditure and voluntary energy intake in habitually active participants, and this study appears to capture the first stages of the change in intake to match an elevated energy expenditure.

Is a history of regular exercise an important factor in the relationship between exercise and appropriate energy regulation abilities?

When looking at already active individuals compared to sedentary individuals, active individuals may have better energy regulation capabilities. In a study by Van Walleghen et al. (19), they compared young and old participants and also active and sedentary participants in each of those groups. They recruited about 14 people for each group: young active, young sedentary, older active, and older sedentary. The younger group consisted of ages 21 to 35, and the older group consisted of ages 60 to 80. The active group spent at least 150 minutes per week engaged in moderate and/or vigorous physical activity for more than two years. Sedentary participants consisted of people who were physically active less than 30 minutes per week. All participants had a BMI of $\leq$30 kg/m$^2$. Participants came into the lab for two lunch meals in random order. One lunch meal consisted of a 30 minute waiting period with no preload followed by an *ad libitum* meal. The other meal consisted of a preload consisting of 500ml for men and 376 ml for women of a commercially available yogurt drink followed 30 minutes later by an *ad libitum* meal. These lunch meals were separated by a minimum of two days. Participants were asked to eat their usual breakfast meal at the same time each day of testing at least 3 hours before they came in. During each participant's time in the lab, hunger was measured with VAS. Results from this study found that the acute ability to compensate at the *ad libitum* test meal for the yogurt preload was lower in the older compared with the younger participants. However, there was no effect of habitual physical activity level on acute ability to compensate, and no age by physical activity level interaction. However, when looking at compensation over the course of the day, intake over the course of the day was not different with age. Though, when active participants were compared to sedentary participants, there was a significantly more accurate compensation effect over the course of the day, meaning the active participants decreased energy intake after the *ad libitum* meal after the yogurt preload session. These results suggest that acute energy intake regulation is impaired in older adults, independent of their activity level. However, energy intake regulation over the course of the day is more accurate in active vs. sedentary adults, which may help maintain long term energy balance.

Results from these investigations indicate that there may be a difference in energy compensation abilities to physical activity in individuals who have a history of engaging in regular and consistent exercise versus sedentary individuals who do not have this history. For example, while individuals who engage in regular physical activity and are of a normal weight status, indicating overall appropriate energy regulation, may not directly compensate calorie for calorie of energy expenditure versus intake, they may be better at regulating intake as compared to individuals who are sedentary, and particularly sedentary, overweight individuals. The importance of regular physical activity on the ability to appropriately self-regulate energy intake concurs with Mayer's original theory (1).

If a history of regular physical activity is important in this relationship, individuals who regularly engage in physical activity and are at a healthy weight status may more accurately respond to an energy deficit caused by an acute period of physical activity by increasing intake at a subsequent meal as compared to sedentary individuals of a normal weight status. Sedentary individuals may not respond to an energy deficit caused by a period of acute physical activity, and instead consume their usual intake at a subsequent meal. However, no research has been conducted testing acute energy regulation capabilities to exercise in active versus sedentary individuals who are of a healthy weight. Thus a direct examination of active versus sedentary individuals' who are of a healthy weight status is required to understand the impact of habitual physical activity as a factor in energy regulation capabilities in response to an acute period of exercise.

Therefore, the purpose of this investigation was to examine acute energy compensation and macronutrient intake in habitually active and sedentary, healthy, normal-weight, unrestrained, college-aged males following exercise. Participants in this study came in for two different sessions: an exercise and a control session, with the exercise and control sessions counterbalanced across participants. The exercise session consisted of participants coming into a lab setting and participating in a moderate/hard-intensity exercise session (cycle ergometer for 45 min), followed by a buffet offered *ad libitum* 60 minutes after the sessions. The control session consisted of participants coming in and quietly reading for the same duration as the exercise session (45 minutes), followed by the same *ad libitum* buffet. Participants also completed a food record for the day of the experimental sessions. It was hypothesized that individuals who regularly engage in physical activity may more accurately respond to an energy deficit caused by an acute period of physical activity by increasing intake at a subsequent meal and during the remainder of the day. Individuals who do not regularly engage in physical activity (sedentary individuals) may be less sensitive to accurately regulate energy balance. Thus, energy consumed from the meal and during the day of the exercise session would be higher than the control session for the active participants, but energy intake would be consistent between the exercise and the control session in the sedentary participants.

**<u>Specific aims</u>:**

1. Determine if habitually active males (those who engage in moderate to intense physical activity for 30 minutes at least five days per week, and have been consistently doing so for at least a month) compensate better to a controlled exercise session at an *ad libitum* buffet meal, than males who maintain a sedentary lifestyle (those who engage in one day or less per week of physical activity for an hour per session, and have been consistent with this regimen for at least a month).
2. Determine if males who maintain a sedentary lifestyle (those who engage in one day or less per week of physical activity for an hour per session, and have been consistent with this regimen for at least a month) maintain a consistent intake at an *ad libitum* buffet meal following an exercise and a control session.

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# **Chapter 2:**

## Abstract

Past research has shown that there may be a difference in the ability to regulate energy intake to energy expenditure, based on how active an individual currently is. This needed to be studied acutely, looking at the amount of energy taken in after an acute period of exercise looking at varying groups. Therefore this study looked at college aged males and there varying amounts of energy and macronutrient intake after a control session and after exercise.

Participants were males, aged 18-30 years, of a normal percent body fat and body mass index, and exercised ≤ 60 min per week (sedentary) or ≥ 150 min per week (habitually active). Participants came in for two sessions: 1) 45 minutes of resting (control) and then eating an *ad libitum* meal; and 2) riding a cycle ergometer for 45 minutes (exercise) and then eating an *ad libitum* meal. Sessions were counterbalanced across participants. Energy and macronutrient intake were calculated for the meal and over the remaining part of the day.

Sedentary individuals ate significantly less during the meal in the exercise session as compared to the control session, which demonstrated negative energy compensation. The habitually active group showed no significant difference in energy intake between sessions at the meal. While the habitually active group showed no significant difference in intake at the meal, the slight increase in intake at the meal in the exercise session demonstrated some energy compensation, which was significantly better than that in the sedentary group. No differences in macronutrient intake at the meal were found between the sessions. Over the day following the sessions, both groups reported a significant increase in energy intake after the exercise session as compared to the control session, with no difference in macronutrient intake between the sessions.

**Introduction:**

The United States is in the midst of experiencing an obesity epidemic (1). In the years 2003-2004 the rates for overweight and obesity were 32.2% and 31.1%, respectively. Since overweight and obesity trends are on the rise, it is likely that this cause of positive energy balance is not only due to an increase in food intake, but also to a decrease in the amount of activity people are getting throughout the day. According to the Centers for Disease Control and Prevention (CDC), in 2007 only 48.8% of adults got physical activity on 5 or more days per week for at least 30 minutes, which are the current recommendations for overall good health (2). This lack of activity may not only contribute to a decrease in energy expenditure but may also contribute to poor energy regulation capabilities, leading to positive energy balance, and consequential overweight and obesity (3).

In the 1950's, Jean Mayer proposed a theory regarding the biological regulation of energy balance, in which there was a central regulatory system that was capable of closely matching energy intake to energy expenditure, and that this system worked with variations in the energy expenditure of an organism to appropriately guide what was consumed (3). In both human and animal research conducted to test this theory, Mayer and colleagues found that regulation of food intake did not function equally well at all physical activity levels (PAL) (3, 4, 5, 6). Regulation of energy intake appeared to be especially poor at low levels of PAL (3, 4, 5, 6), and at low levels of PAL, energy intake was above energy expenditure levels, leading to a positive energy balance state.

Recent experimental human research regarding the acute effects of exercise on food intake does suggest that normal weight (body mass index [BMI] of 18.5 to 24.9 kg/m$^2$) individuals who engage in regular physical activity (i.e., moderately active for at least 30 minutes per day, 5 days per week) may more appropriately regulate intake as compared to sedentary (i.e., active less than 60 minutes per week) normal weight and overweight individuals (7, 8, 9, 10, 11). Research with individuals who are habitually active has found that in general energy intake is increased in a meal consumed one hour after a single bout of exercise as compared to a meal consumed one hour after no bout of exercise (7). When the acute effect of exercise on food intake is examined in sedentary, normal and overweight participants, intake in a meal consumed 60 minutes following a single bout of exercise is generally not increased as compared to a control session with no exercise, indicating poor energy compensation (8, 9, 10, 11). Other studies investigating the effects of increasing activity in previously sedentary individuals have found improvements in energy compensation capabilities after regularly engaging in exercise. This indicates that increasing regular physical activity over time may improve compensation abilities, and thus energy regulation, in individuals (12, 13).

These investigations indicate that there may be a difference in energy regulation, and thereby energy compensation, between individuals who have a history of engaging in regular and consistent exercise versus sedentary individuals who do not have this history. Currently, no research has been conducted testing acute energy compensation capabilities to exercise in active versus sedentary individuals who are of a healthy weight. Thus the purpose of this investigation was to examine acute energy compensation and macronutrient intake in habitually active and sedentary, healthy, normal weight (BMI of 20-24.9 $kg/m^2$), unrestrained, college-aged males following exercise. Participants were counterbalanced in this study and participated in two sessions: an exercise session (cycle ergometer for 45 min at 65-75% Hrmax) and a control session (reading or writing for 45 min) and consumed an *ad libitum* meal 60 minutes after the exercise or control session. It was hypothesized that individuals who were habitually active would more accurately respond to the acute period of physical activity by increasing intake at an *ad libitum* meal served 60 minutes following the physical activity as compared to the sedentary individuals.

**<u>Experimental Design and Methodology</u>:**

<u>Research design</u>

This study used a 2 x 2 mixed factorial design, with the between-subject factor of history of activity (habitually active vs. sedentary), and the within-subject factor of session (exercise vs. control). The primary dependent variables were energy and macronutrient intake consumed in the *ad libitum* buffet meal in the session. Secondary outcomes included compensation ability during the *ad libitum* buffet meal, hunger during the experimental sessions, and energy and macronutrient intake in the day after the experimental sessions, as assessed by a food record.

<u>Participants</u>

Participants met the following criteria to be eligible for the study. Males, 18 to 30 years of age, and:

1) Able to perform physical activity (i.e., jog) at an intensity of 70% maximum heart rate.
2) Unrestrained eater (scoring $\leq$ 12 on the restraint scale of the Three Factor Eating Questionnaire [14]).
3) Free of food allergies to foods used in the investigation.
4) Like and willing to consume foods used in the investigation.
5) Weight stable for at least 6 months.
6) BMI of 20.0 to 24.9 $kg/m^2$.

7) Percent body fat of 10.0% to 18.0%.
8) Free of physical or psychiatric diseases that may affect eating (i.e., depression or a previous bout with an eating disorder).
9) No health conditions that may affect ability to engage in physical activity or require dietary restrictions.
10) Take no medications that may influence eating.
11) Non-smoker.
12) Can complete sessions within specified time period of completing both sessions on at the same time on the same day of the week within one month of each other.

Participants in the study met criteria for being in either the active or sedentary group. The active group consisted of 10 males who engaged in moderate-intense physical activity for at least 30 minutes per day at least five days per week, and self-reported engaging in this level of activity for at least the previous month. The sedentary group consisted of 10 males who participated in moderate-intense physical activity one day or less per week for no more than a total of 60 minutes per week, and self-reported engaging in this level of activity for at least the previous month.

Participants were recruited through ads and flyers posted around the campus describing a study that examined how exercise influences the liking of foods. Potential participants were phone screened to see if they qualified for the study. If they qualified for the study, they were scheduled for the two sessions, with both sessions completed at the same time and the same day of the week, and within a one-month period. The study was approved by the Institutional Review Board at the University of Tennessee Knoxville.

From the flyers posted around campus and through word-of-mouth, 47 potential participants were phone screened to determine eligibility for the study. Of the 47 individuals phone screened, 27 were ineligible for the following reasons: did not exercise within the definitions of one of the two groups (9), did not have enough time in their schedules (6), not liking all the foods in the study (5), didn't fall within the anthropometric criteria (3), food allergies (2), and were restrained eaters (2).

<u>Procedures</u>

Each participant came in for an initial session in the morning, between 9:30 and 11:30 am. They were instructed to eat prior to coming to the session in their usual manner, and to eat a consistent breakfast prior to both sessions. In the first session, informed consent was obtained, and participant's height, weight, and percent body fat was measured to ensure their eligibility to continue to participate in the study. The exercise session and the control session were counterbalanced across the participants.

For the exercise session, participants engaged in physical activity at an intensity that was 65 – 75% of their maximum heart rate (using the formula for heart rate of 220 minus the participant's age), and that produced a caloric expenditure of approximately 450 kilocalories (kcal). To achieve this, participants rode a cycle ergometer for 45 min at 2 kilopounds (KP) of resistance. While the participants rode the bike, they had the choice to watch a "Family Guy" greatest hits DVD movie or to just ride the bike without any distractions. Each participant also wore a Polar heart rate monitor, which measured their heart rate to insure they stayed between 65% and 75% of their estimated maximum heart rate. Once a steady heart rate was established, the participants were asked to stay at the bike speed (revolutions per min [rpm]) that produced the 65% to 75% estimated maximum heart rate. Participants' heart rate was assessed every five minutes to ensure that participants' heart rate stayed in the specified range. Additionally, during the session, participants were asked to rate their hunger using a visual analog scale (VAS) every 10 minutes by pointing to a spot on the line, which was then marked by the researcher.

Following the exercise, the participants were given a 60 minute break. During this time, participants continued to rate their hunger every 10 minutes, and completed a record of what they had consumed in the morning prior to their session. Their recent physical activity was also assessed using the 7-day physical activity recall (15).

At the completion of 60 minutes, they were asked to eat the supplied buffet meal *ad libitum*. Participants were instructed to eat as much or as little of any combination of the food items, and to eat until satisfied. The amounts of each food that were supplied in the buffet meal are in Table 1 found in Appendix B.

In the meal, food items were portioned into small sizes as to not influence consumption. All food was supplied to each participant in a room where the participant had 20 minutes to eat lunch. The researcher was not in the room during the time the participant ate, as to not influence consumption.

Upon completion of their meal, participants rated their hunger again, reported their liking of the foods consumed in the meal using a VAS, and were instructed on how to complete a food diary for what they consumed for the remaining part of the day. Participants were given a self-addressed, stamped envelope so that they could return the completed diary via mail.

The control session occurred on the same day and time as the exercise session, and participants were asked to sit and read or do homework. Each participant did a standard resting session time of 45 minutes. As in the exercise session, they rated their hunger using the same procedures. Following the control session, participants had a 60 minute break and followed the same procedures as in the exercise session. Following completion of both sessions, participants were debriefed and provided with $30 compensation.

Measures

*Anthropometrics:* Height and weight were measured with participants wearing no shoes and in light clothing, using standard procedures (16). Weight and height were measured with a health professional portable electronic scale/stadiometer (Heathometer Professional model 597KL; Pellstar Sunbeam Products Inc., Hattisburg, MS). Weight was measured to the nearest 0.2 lbs when the participants stepped on the scale, and height was measured to the nearest 1/8 inch. BMI was determined using the formula: weight in kg divided by height in meters squared (16). Body composition was determined by bioelectrical impedance (Tanita Body Composition Analyzer, Model TBF-300A; Tanita Corperation of America Inc., Arlington Heights, IL). Participants stepped on the scale barefoot, wearing minimal clothing, and percent body fat was measured once sex, height, and clothes weight were entered into the scale.

*Regular physical activity*: Regular physical activity was assessed using the 7-day physical activity recall to ensure that participants met criteria for the active or sedentary group for which they had been placed into based upon information obtained during the phone screening (15). For this recall, participants were interviewed and asked about the number of hours spent in sleep, moderate, hard, and very hard activities during the preceding week. Examples of the types of activities in each category were provided, and the week was separated into weekend days and weekdays. This was given during the 60 min break periods between the exercise/rest session and the meal.

*Dietary restraint*: The Three-Factor Eating Questionnaire contains a dietary restraint factor (contains 21 items with higher scores indicating greater levels of dietary restraint), which assesses the tendency to cognitively restrict food intake to control body weight (14). While this questionnaire also measures disinhibition and perceived hunger, participants only completed items related to the dietary restraint factor. This questionnaire was given as a part of the phone screen to determine participant eligibility for the study.

*Energy expenditure during exercise session:* Energy expenditure was estimated for each participant based on the American College of Sports and Medicine's (ACSM) equation for power and leg cycling equation for gross $VO_2$ (17, 18):

5) Power

Power (kpm/min) = Force (kp) x Velocity (revolutions per min x meters per pedal revolution)

Meters per pedal revolution is a standard 6 for a Monark bike, and rpm depended on what was needed to elevate the heart rate of each participant to 65% to 75% maximum heart rate. The rpm was on the display screen on the bike, and the participant stayed at the same rpm throughout the session once proper heart rate was reached.

2) Power output of kpm/min is converted to Power output of kgm/min

This is a 1:1 conversion. 1 kpm/min = 1 kgm/min. In essence, a 1 kp weight is the gravitational force acting upon a 1 kg mass on earth's surface.

3) Energy expenditure, gross VO2 equation

VO2 (mL/kg/min) = [(1.8 mL/kg/min) x (work rate in kgm/min) / (body mass in kg)] + 7 mL/kg/min.

4) Gross VO2 (mL/kg/min) is converted to VO2 (L/min)

Gross VO2 x body mass (kg)/ 1000

5) Energy expenditure (kcals)

VO2 (L/min) x min of activity x 4.8 kcal/L*

*4.8kcal used as a standard based on literature assuming an R-value of around 0.8 (18).

An example of calculating energy expenditure achieved in the study:

1) Power (kpm/min) = 2kp x (71 rpm x 6 mpr)
2) Power = 852 kpm/min which also equals 852 kgm/min
3) Gross VO2 (mL/kg/min) = [(1.8 mL/kg/min x 852 kgm/min)/(78.4 kg)] + 7 mL/kg/min = 26.56 mL/kg/min
4) VO2 = (26.56 mL/kg/min x 78.4 kg)/1000 = 2.0824 L/min
5) Energy expenditure = 2.0824L/min x 45 min x 4.8 kcal/L = 449.8 kcals

*Dietary intake in the ad libitum buffet meal*: The foods served in the buffet meal were weighed to the nearest tenth of a gram, using a Denver Instrument electronic food scale (Model SI-8001; Arvada, CO), before and after the meal. The amount consumed of each food was determined by subtracting the post-meal amount from the pre-meal amount. The calorie intake was determined by multiplying grams consumed by calorie per gram information obtained from the food manufacturers' labels.

*Percent compensation in energy intake of the ad libitum meal:* Once energy expenditure was determined for each participant, and energy intake from each of the two *ad libitum* meals was calculated, percent compensation in energy intake was calculated. The equation to calculate the percent compensation was:

> [(Lunch energy intake during exercise session – Lunch energy intake during resting session) / Energy expenditure during exercise session] x 100

Possible values for percent compensation could be negative or positive numbers. Positive numbers indicated greater intake in the meal in the exercise session as compared to the control session, while negative numbers indicated greater intake in the meal in the control session as compared to the exercise session. Perfect compensation (consumed enough extra energy in the exercise session at lunch as compared to the control session to cover the energy expended in the exercise session) would be a value of 100%, while a value of 0% would equal no compensation (energy intake at the two lunches were identical). Negative values for compensation would show a greater intake in energy during the control session as compared to the exercise session, showing an actually decrease in compensation abilities.

*Dietary intake over 24-hrs*: Information about specific foods consumed, amount, and time of day was collected from participants on the day of each session. First, participants wrote the information of what was consumed in the day prior to the session in the 60 minute break between the exercise or control session and the *ad libitum* meal. Also each participant was given a food record and was instructed on how to complete this to report what was consumed during the remaining part of the day after the experimental session. Participants were given two-dimensional models to aid with their reporting of amounts of food consumed. Participants were provided with self-addressed envelopes to mail in the continued food records at the completion of the day. Dietary data was analyzed using Nutrition Data Systems for Research (NDSR) software (University of Minnesota, Nutrition Coordinating Center) to analyze for macronutrient and energy content of each food consumed.

*Hunger and liking of foods*: A VAS, which was a 100 mm scale (19), anchored on the left end, with "extremely hungry" and on the right end, with "extremely full" was used to allow participants to rate their feelings of hunger throughout the sessions. Thus, higher ratings indicated less hunger and lower ratings indicated greater hunger. Participants reported their hunger every ten minutes throughout the session. Participants rated their hunger at the start of the session, 4 times during the exercise or resting component of the session, 7 times during the 60 minute break between the exercise/rest session and the *ad libitum* meal, and 1 time after completing the meal. Thus, hunger was rated 13 times in the session.

Additionally, a 100 mm VAS, anchored on the left end, end with "extremely dislike" and on the right end, with "extremely like," was also used to assess participants' liking of the foods used in the investigation after the *ad libitum* meal in each session. While this was not a measure analyzed in the investigation, it was collected as participants had been told the purpose of the study was to look at the liking of foods after the exercise and control sessions.

Statistical analysis

Baseline characteristics, except for PAR hours, between the habitually active and sedentary groups were analyzed using independent t-tests for continuous data and Chi-square tests for categorical data. PAR hours were analyzed using a mixed factorial analyses of variance (ANOVA), with a between-subject factor of group (habitually active vs. sedentary), and a within-subject factor of session (exercise vs. control). To ensure that factors that might influence consumption (i.e., hunger, hours since last eaten, and energy and macronutrient intake in the morning prior to the experimental sessions) were not different between groups and experimental sessions, mixed factorial ANOVA were conducted, using a between-subject factor of group (habitually active vs. sedentary), and the within-subject factor of session (exercise vs. control). Mixed factorial analyses of covariance (ANCOVAs) using a between-subject factor of group (habitually active vs. sedentary), and the within-subject factor of session (exercise vs. control), controlling for percent body fat since it was significantly different between the groups, were conducted to examine energy and macronutrient intake at the *ad libitum* buffet meal and for energy and macronutrient intake after the sessions. An ANCOVA, with percent body fat controlled, was used to analyze percent compensation. Hunger ratings taken before the *ad libitum* meal were analyzed using a mixed factorial ANCOVA, with the between-subject factor of group (habitually active vs. sedentary), and the within-subject factors of session (exercise vs. control), and time (hunger ratings 1 to 12), with percent body fat controlled. The hunger ratings directly before and directly after the *ad libitum* meal were also analyzed using a mixed factor

ANCOVA, with the between-subject factor of group (habitually active vs. sedentary), and the within-subject factors of session (exercise vs. control), and time (hunger ratings 12 and 13), with percent body fat controlled. Where appropriate, Greenhouse – Geisser probability levels were used to adjust for sphericity. For significant outcomes, post-hoc comparisons with Bonferroni adjustments were conducted. Statistical significance was set at $p \leq 0.05$. Statistical analyses were conducted with SPSS, version 17 (20).

## Results:

### Participants

Participant demographic characteristics are listed in Appendix B in Table 2. Participants in this investigation were 21.2 ± 1.9 years of age, had a BMI of 23.4 ± 1.7 kg/$m^2$, and were unrestrained eaters (4.2 ± 3.1). Participants were 95% White and 10% were Hispanic/Latino. There were no significant ($p > 0.05$) differences in age, BMI, dietary restraint, race, or ethnicity between the habitually active and sedentary groups. Percent body fat was significantly different between the two groups, with the habitually active group lower in percent body fat than the sedentary group (12.6 ± 2.8% vs. 15.0 ± 2.3%; $t = 2.101$, $df = 18$, $p < 0.001$), and thus was controlled in analyses of the primary dependent variables. Additionally, as expected, the habitually active group reported significantly more minutes per week in physical activity than the sedentary group (438.2 ± 151.9 minutes/week vs. 31.5 ± 42.5 minutes/week; $F_{1,18} = 39.6$, $p < 0.05$).

### Energy expended in exercise session

For the exercise session, the average revolutions per minute pedaled for the 45 minutes of exercise was 71 ± 1.8 rpms and 72.3 ± 1.3 rpms for the habitually active and sedentary group, respectively, showing no significant ($p > 0.05$) difference between groups. The average percent of heart rate max achieved in the exercise session was significantly different between the two groups, with the sedentary group achieving a higher level than the habitually active group (71.1 ± 2.4% max vs. 68.9 + 1.7% max; $t = 3.006$, $df = 18$, $p < 0.01$). However, the energy expended during the 45 minutes on the cycle ergometer was not significantly ($p > 0.05$) different between the two groups, with the habitually active group expending 455.8 ± 8.9 kcals and the sedentary group expending 451.3 ± 11.6 kcals.

### Time since breakfast, hunger, and dietary intake before sessions

There was no significant ($p > 0.05$) interaction of group by session, or significant main effect of group or session for time between the breakfast meal and the start of the sessions. The time between breakfast and the control session was 85.7 ± 67.6 minutes and the time between breakfast and the exercise session was 75.3 ± 52.3 minutes.

There was also no significant ($p > 0.05$) interaction of group by session, or significant main effect of group or session for ratings of hunger at the start of each session. The mean initial hunger rating for the exercise session was 61 ± 16 mm while the mean initial hunger rating for the control session was 63 ± 15 mm.

Lastly, there was no significant ($p > 0.05$) interaction of group by session, or significant main effect of group or session on energy intake or percent energy from fat, carbohydrate, or protein consumed prior to the sessions. The mean energy intake prior to the exercise session was 369.3 ± 159.5 kcals and for the control session was 388.1 ±167.9 kcals. The mean percent energy intake from fat, carbohydrate, and protein prior to the exercise session was 19.5 $\pm$ 12.2%, 67.0 $\pm$ 15.5%, and 13.5 $\pm$ 10.3%, respectively. The mean percent energy intake from fat, carbohydrate, and protein prior to the control session was 20.1 $\pm$ 11.2%, 66.1 $\pm$ 12.9%, and 13.8 $\pm$ 9.8%, respectively.

Energy and macronutrient intake at the *ad libitum* lunch buffet meal

The energy and macronutrient intake at the *ad libitum* lunch buffet meal for the active and sedentary groups at both sessions is presented in Appendix B in Table 3. There was a significant group by session interaction ($F_{1,17} = 3.929$; $p < 0.05$) for energy intake. Pairwise comparisons showed the sedentary group had a significantly higher energy intake during the control session than during the exercise session (1073.9 $\pm$ 470.3 kcals vs. 934.8 $\pm$ 222.0 kcals, $p < 0.03$). The mean intake for the habitually active group was 1016.8 $\pm$ 396.7 kcal for the control session and 1105.6 $\pm$ 389.2 kcal for the exercise session, with no significant difference ($p > 0.05$) occurring between the sessions in energy intake for the habitually active group. There was no significant interaction ($p > 0.05$) of group by session, or significant main effect of group or session, for percent of energy from fat, carbohydrate, or protein consumed in the *ad libitum* lunch buffet meal.

Percent compensation

Percent compensation to the energy expenditure achieved in the exercise session for each group is shown in Appendix B in Figure 1. There was a significant difference in compensation between the two groups ($F_{1,17} = 5.126$; $p < 0.03$), with the habitually active group demonstrating some compensation and the sedentary group demonstrating negative compensation.

Hunger

The hunger ratings for each group by session are shown in Appendix B in Figure 2. Analyses showed there was a significant ($F_{1,17}$ = 2.62; $p < 0.04$) three-way interaction for hunger. Subsequent analyses demonstrated that the habitually active group in the control session had significantly higher hunger ratings, indicating less hunger, than the sedentary group in the exercise session at hunger ratings 9, 10, 11, and 12 ($p < 0.05$). The mean hunger ratings for the habitually active group for the control session were 40 $\pm$ 15 mm, 41 $\pm$ 14 mm, 40 $\pm$ 12 mm, and 33 $\pm$ 16 mm, for hunger ratings 9, 10, 11, and 12, respectively. The mean hunger ratings for the sedentary group during the exercise session were 32 $\pm$ 16 mm, 27 $\pm$ 14 mm, 23 $\pm$ 13 mm, and 21 $\pm$ 13 mm, for hunger ratings 9, 10, 11, and 12, respectively.

Analyses of the hunger rating taken prior to the *ad libitum* buffet meal and after consumption of the *ad libitum* buffet meal showed a main effect of time ($F_{1,17}$ = 5.84; $p < 0.05$). There was no significant interaction ($p > 0.05$) or main effect of group for hunger prior and after the *ad libitum* buffet meal. The mean hunger rating prior to the meal was 25 $\pm$ 15 mm and the mean hunger rating after the meal was 82 $\pm$ 11 mm for both groups and sessions combined.

Energy and macronutrient intake after session

The energy and percent energy from the macronutrients consumed during the remainder of the day after each session for each group is shown in Appendix B in Table 3. A significant main effect of session ($F_{1, 17}$ = 4.773; $p < 0.04$) was seen in energy intake, with more energy consumed after the exercise session as compared to the control session (1457.5 $\pm$ 646.2 kcals vs. 1356.1 $\pm$ 657.2 kcals). There was a trend ($p = 0.052$) seen towards a potential group effect, with the sedentary group having a higher energy intake after both sessions than the habitually active group, however this was not statistically significant.  The percent of energy from fat and carbohydrate consumed showed no significant ($p > 0.05$) group by session interaction, or main effect of group or session.  However, percent of energy from protein consumed showed a significant main effect of group ($F_{1, 17} = 5.68$; $p < 0.03$) with the habitually active group consuming a significantly greater percent energy from protein as compared to the sedentary group (22.3 ± 10.6% vs. 14.7 ± 5.2%).

**Discussion:**

The purpose of this investigation was to examine acute energy compensation and macronutrient intake in habitually active and sedentary, healthy, normal-weight, unrestrained, college-aged males following exercise.  It was hypothesized that individuals who regularly engage in physical activity may more accurately respond to an energy deficit caused by an acute period of physical activity by increasing intake at a subsequent meal and during the remainder of the day.  Individuals who do not regularly engage in physical activity (sedentary individuals) may be less sensitive to accurately regulate energy balance and were hypothesized to not increase intake at a subsequent meal or later in the day following an acute period of physical activity.  Thus, energy consumed from the meal and during the day following the exercise session would be higher than the control session for the habitually active participants, but energy intake would be consistent between the exercise and the control session in the sedentary participants.  Results from this study do provide some support that college-aged males who do participate in regular physical activity appear to compensate more accurately in a meal consumed after an exercise bout than sedentary college-aged males.

In the exercise sessions, both groups of participants expended approximately 450 kcals, and therefore for perfect acute compensation, the participants would have had to take in an extra 450 kcals on top of what was eaten during the control session during the *ad libitum* lunch buffet. While there was a slight increase in energy intake in the *ad libitum* lunch buffet for the physically active group in the exercise session, the difference in intake between the exercise and the control session was not significantly different. However, for the sedentary group, energy intake at the *ad libitum* meal in the exercise session was significantly lower than during the control session. This shows that the sedentary group actually ate less in response to expending more energy in the exercise session as compared to what was expended in the control session. While differences in energy intake occurred between the two sessions for the sedentary group, there was no difference seen in percent of macronutrients consumed. Additionally, no differences were found for percent macronutrient intake between the two sessions for the habitually active group.

When the ability to compensate at the *ad libitum* meal was examined, the habitually active group did demonstrate some compensation to the energy deficit produced in the exercise session. However, while this group did compensate, rather than achieving complete compensation (100%), the group achieved 19.6% compensation. In contrast to this, the sedentary group demonstrated negative compensation (-30.6%), as this group consumed less in the meal following exercise as compared to the control session.

When looking at energy intake and percent compensation occurring at the *ad libitum* lunch, one factor that needs to be considered is a change in hunger over the course of the sessions. When looking at this study, it was found that the habitually active group was significantly less hungry after the control session, compared to the sedentary group in the exercise session. Thus, if hunger ratings are an indicator of what actually may be consumed in regards to energy, it might be expected that the habitually active group would consume less in the control session than the sedentary group in the exercise session. This outcome was not found in regards to energy intake. Interestingly, the sedentary group ate less in the *ad libitum* meal in the exercise session as compared to the control session. These results may indicate that hunger ratings may not be a good indicator of energy intake in normal-weight, sedentary males.

Moreover, when hunger ratings before and after the *ad libitum* lunch buffet meal were examined, it is important to note there were no differences in ratings between the groups or sessions. This is most important to regards to the hunger ratings taken after meal, especially for the sedentary group. For the sedentary group, as there were no differences in hunger ratings between the sessions after the *ad libitum* meal, but there was a difference in energy intake during the meal in the two sessions, this again suggests that hunger ratings may not be accurate indicators of energy intake for sedentary, normal-weight, males.

For energy and macronutrient intake consumed after the sessions, both groups showed an increase in energy intake after the exercise session compared to that of the control session. This shows that there may have been more compensation occurring over the course of the day. Thus potentially the habitually active group is more acutely sensitive to energy regulation, and started to compensate for the deficit incurred by the exercise session during the *ad libitum* meal, and then continued to compensate over the course of the day. The sedentary group showed less sensitivity to energy regulation during the meal, and in fact showed a reduction in energy intake and no compensation. However, the greater intake later in the day for the sedentary group indicates that while potentially compensation would occur, it might just require a longer time frame to occur. For macronutrient intake in the day following the sessions, it was found that there was a difference in the two groups in percent energy consumed from protein, with the habitually active group consumed a higher percentage of energy from protein as compared to the sedentary group. However, there was no difference in the percentage of macronutrients consumed between the two sessions.

This finding of better compensation in habitually active people is similar to what has been found in previous studies, with participants having better compensation ability when they are habitually physically active (7). This is consistent with what Jean Mayer found, in some of the first research done in this area (3, 4, 5, 6). The finding that sedentary people have an actual decrease in compensation in an initial engagement in physical activity (i.e., eat less following acute physical activity) is also consistent with what Mayer found in his rat study (4). This suggests that when individuals do not engage in regular physical activity, it is more challenging to match energy intake to energy expenditure.

Results from this study indicate that normal weight males who are habitually active may regulate intake more appropriately than those who are not regularly active. This finding may also have implications for the importance of physical activity in weight loss and weight maintenance aside from increasing energy expenditure. If people are regularly physically active, meaning they maintain the recommendations made by the CDC of at least 30 minutes per day, 5 days per week, they may have better regulation capabilities (2). Therefore if a person loses weight through diet and exercise, and if this exercise is maintained even after the weight loss is achieved, the person may have a better innate regulatory system for maintaining an energy-balance state required for weight maintenance. Additionally, this data suggests when individuals are not regularly active, when they engage in physical activity, hunger does not increase and intake does not increase soon after the activity to offset energy expended in the physical activity.

Thus, for those sedentary individuals who are trying to lose weight by increasing physical activity, at least initially, compensation may not occur, helping to incur the deficit required for weight loss. Finally, these results may also have implications on preventing obesity. If physical activity can be increased to appropriate levels, appropriate energy regulation may occur, again aiding with energy balance.

Strengths of this study include the controlled research design and objective measures used in the study. For example, for the exercise sessions, each participant engaged in the same type of exercise that was monitored, with heart rate measured every 5 minutes. The *ad libitum* lunch buffet allowed an objective measure of intake, and as participants were given the same meal across sessions and groups, differences in intake could not occur due to differences in the types of foods chosen to eat at the meal. Additionally, participants were of a normal BMI and percent body fat and were not restrained eaters, and therefore were most likely at an energy balanced state (i.e., not already in a positive energy balance state which would indicate difficulties with energy regulation).

However, there are a few limitations to this study. First, the sample was very homogenous, thus it is not clear if factors such as sex, weight and body composition status, age, and dietary restraint may moderate the effects found in the study. Another limitation to the study was the use of a food record for analyzing energy intake over the course of the day after the sessions. As compared to the recall done for intake prior to each session, which was reviewed with participants during the session, and the intake for the *ad libitum* lunch meal, which was objectively measured, the food diary was not reviewed with participants and it is not clear if participants completed the diary soon after eating, as they had in the session. Thus, this measure of intake may be less accurate than the other measures of intake. A better way of measuring this may have been to call each participant the following day and collect a dietary recall of what was consumed the previous day following the session.

Future directions in this area of research include examining the influence of regular physical activity in compensation abilities in differing populations (i.e., overweight individuals, females, etc.). Additionally, it would be important to examine individuals who are in the process of initially losing weight and who have recently lost weight and are trying to maintain the weight loss responses to an acute exercise trial on hunger and intake, as the changes in energy balance states themselves may have an impact on energy regulation capabilities. This research can be important for helping to inform individual who are losing weight and increasing exercise as to what might be expected in terms of changes in appetite and energy compensation abilities in response to regular, increased physical activity.

Overall this study looked at the effects of a single exercise bout on energy and macronutrient intake, comparing sedentary and habitually active college-aged males. The hypothesis was that individuals who regularly engage in physical activity may more accurately respond to an energy deficit caused by an acute period of physical activity by increasing intake at a subsequent meal and during the remainder of the day. Individuals who do not regularly engage in physical activity (sedentary individuals) may be less sensitive to accurately regulate energy balance. The results from this study indicated that, although complete compensation was not seen in either group, the habitually active group compensated intake significantly more so than the sedentary group, demonstrating better regulation ability. These findings provide more evidence that engaging in regular physical activity may be important in the energy balance equation, not only for increasing energy expenditure, but for improving energy regulation capabilities.

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## **Conclusion:**

Participants were counterbalanced in this study and participated in two sessions: an exercise session (cycle ergometer for 45 min at 65-75% HRmax) and a control session (reading or writing for 45 min) and consumed an *ad libitum* meal 60 minutes after the exercise or control session. It was hypothesized that individuals who were habitually active would more accurately respond to the acute period of physical activity by increasing intake at an *ad libitum* meal served 60 minutes following the physical activity as compared to the sedentary individuals.

This study found that sedentary individuals ate significantly less during the meal in the exercise session (which expended a mean of 453.5 kcals across both groups) as compared to the control session (934.8 $\pm$ 222.0 kcals vs. 1073.9 $\pm$ 470.3 kcals, $p < 0.03$), which demonstrated negative energy compensation (-30.6%). The habitually active group showed no significant difference in energy intake between sessions at the meal (1016.8 $\pm$ 396.7 kcal [control] vs. 1105.6 $\pm$ 389.2 kcal [exercise]). While the habitually active group showed no significant difference in intake at the meal, the slight increase in intake at the meal in the exercise session demonstrated some energy compensation (19.6%), which was significantly better ($p < 0.03$) than that in the sedentary group. No differences in macronutrient intake at the meal were found between the sessions. Over the day following the sessions, both groups reported a significant increase in energy intake after the exercise session as compared to the control session (1457.5 $\pm$ 646.2 kcals vs. 1356.1 $\pm$ 657.2 kcals, $p < 0.04$), with no difference in macronutrient intake between the sessions.

The results indicate that, although complete acute compensation did not occur, the habitually active group acutely compensated intake significantly more so than the sedentary group, demonstrating better energy regulation ability.  This finding goes along with previous studies, where a better energy regulating system was seen in habitually active individuals.

## **Appendices:**

## Appendix A: Chapter 1 Figures

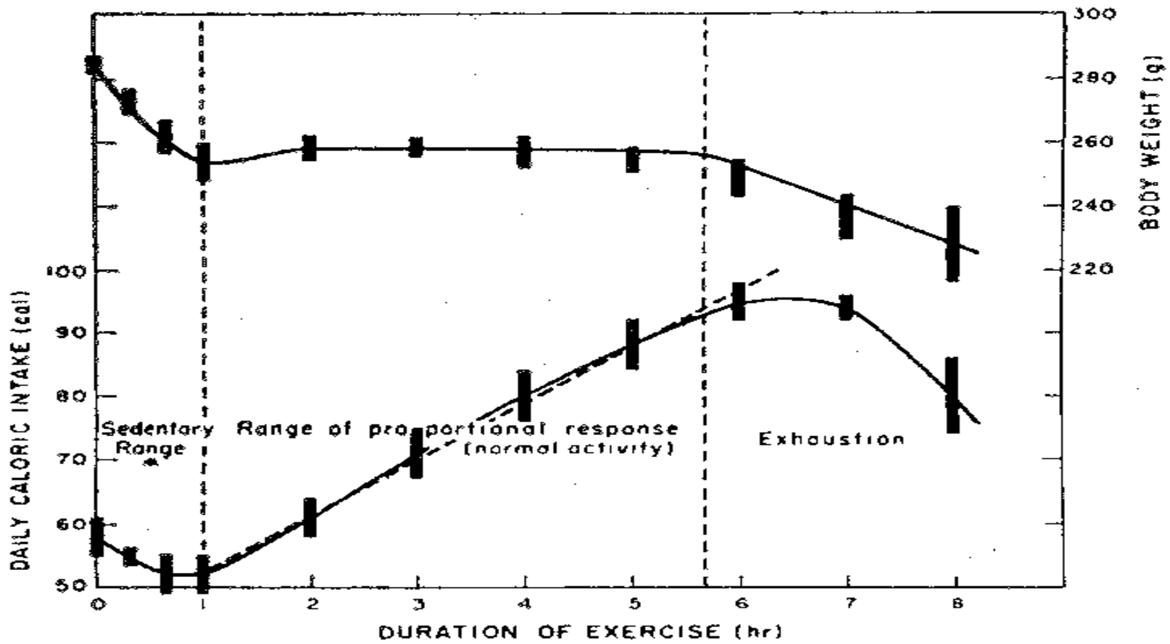


Figure 1: Jean Mayers "normal activity range" theory

Showing an increase in energy intake only within a "normal" range of activity.

Source: Mayer J. *Science, p.330:* 1967.

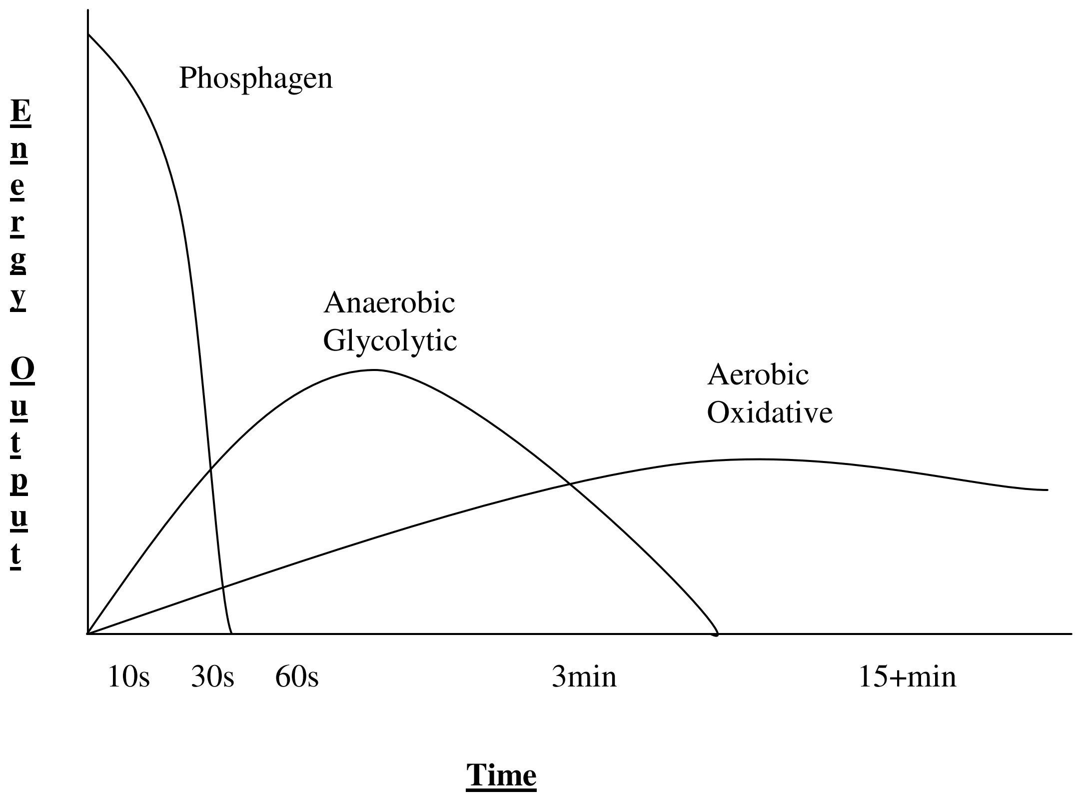


Figure 2: The human body’s energy systems during exercise

The Phosphogen pathway is used as an energy source for short duration exercise and high energy output. The Anaerobic Glycolytic pathway is for moderate duration and moderate energy output. The Aerobic Oxidative pathway is used for longer, low energy output activities.

Source: Wells GD. *Ped Resp Review,* p. 86:1994.

# Appendix B: Chapter 2 Tables and Figures

Table 1: Food items, grams, and caloric content of *ad libitum* lunch

| *Item* | Grams | Fat (g) | Calories (Kcal) |
|---|---|---|---|
| Sandwich* | 327.0 | 5.7 | 264.0 |
| Deli Roll | 105.0 | 4.9 | 142.5 |
| Deli Select Turkey | 85.5 | 0.8 | 90.0 |
| Kroger Dijon Mustard | 15.0 | 0.0 | 0.0 |
| Kraft Fat-free Mayonnaise | 16.5 | 0.0 | 10.5 |
| Lettuce | 15.0 | 0.0 | 1.5 |
| Tomato | 90.0 | 0.0 | 19.5 |
| Orange Slices | 393.0 | 0.0 | 184.5 |
| Apple Slices | 364.0 | 0.6 | 190.0 |
| Carrot sticks | 122.0 | 0.3 | 50.0 |
| Snyders Pretzels | 127.5 | 0.0 | 501.0 |
| Doritos Nacho Cheese Tortilla Chips | 126.0 | 33.6 | 630.0 |
| Country Club Vanilla fudge swirl ice cream | 373.5 | 35.0 | 807.0 |
| Hershey Candy Bar | 183.0 | 61.0 | 840.0 |
| Total for the meal | 2997.0 | 153.3 | 4258.5 |

* For each buffet meal, participants were be given 4 full deli sandwiches.

Table 2: Participant demographics ($M \pm SD$)*

| | Habitually Active (n = 10) | Sedentary (n = 10) |
|---|---|---|
| Age (yrs) | $21.4 \pm 2.1$ | $20.9 \pm 1.9$ |
| BMI ($kg/m^2$) | $23.9 \pm 1.5$ | $23.0 \pm 1.9$ |
| Body Fat (%) | $12.6 \pm 2.8^a$ | $15.0 \pm 2.3^b$ |
| Dietary Restraint | $4.6 \pm 2.9$ | $3.7 \pm 3.4$ |
| Average PAR (min/wk) | $438.2 \pm 151.9^a$ | $31.5 \pm 42.5^b$ |
| Race (%) | | |
| White | 90 | 100 |
| Black or African American | 10 | 0 |
| Ethnicity: Hispanic or Latino (%) | 0 | 20 |

*Means with different superscripts within categories are significantly different ($p<0.05$).

Note: BMI = body mass index , PAR= physical activity recall

Table 3: Energy and macronutrient intake at *ad libitum* buffet lunch* (M ± SD)

| | | Habitually Active | Sedentary |
|---|---|---|---|
| Energy Intake (kcal) | Exercise | 1105.6 ± 389.2[ab] | 934.8 ± 222.0[a] |
| | Control | 1016.8 ± 396.7[ab] | 1073.0 ± 470.3[b] |
| Carbohydrates (% energy) | Exercise | 41.7 ± 2.3 | 47.67 ± 7.4 |
| | Control | 43.7 ± 3.1 | 46.31 ± 5.0 |
| Protein (% energy) | Exercise | 24.5 ± 4.5 | 19.78 ± 3.7 |
| | Control | 23.3 ± 4.7 | 21.54 ± 3.0 |
| Fat (% energy) | Exercise | 33.8 ± 4.3 | 32.58 ± 5.1 |
| | Control | 33.1 ± 3.6 | 32.16 ± 6.4 |

*Means with different superscripts within categories are significantly different ($p < 0.01$).

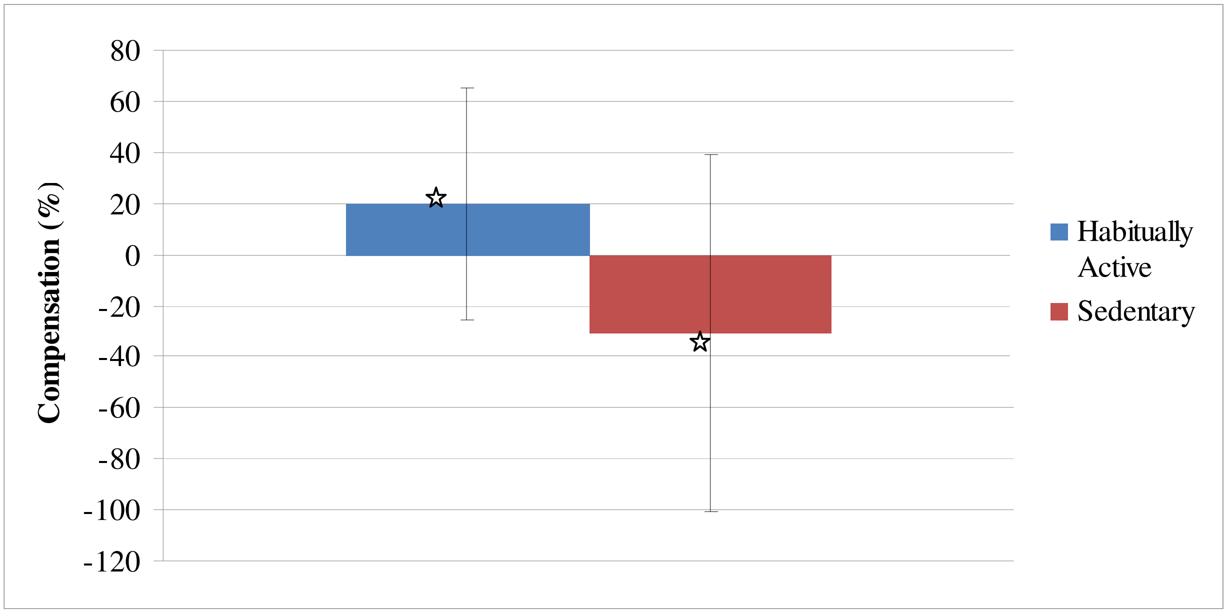


Figure 3: Percent compensation in intake at the *ad libitum* meal

☆ Significant main effect of group ($p<0.03$)

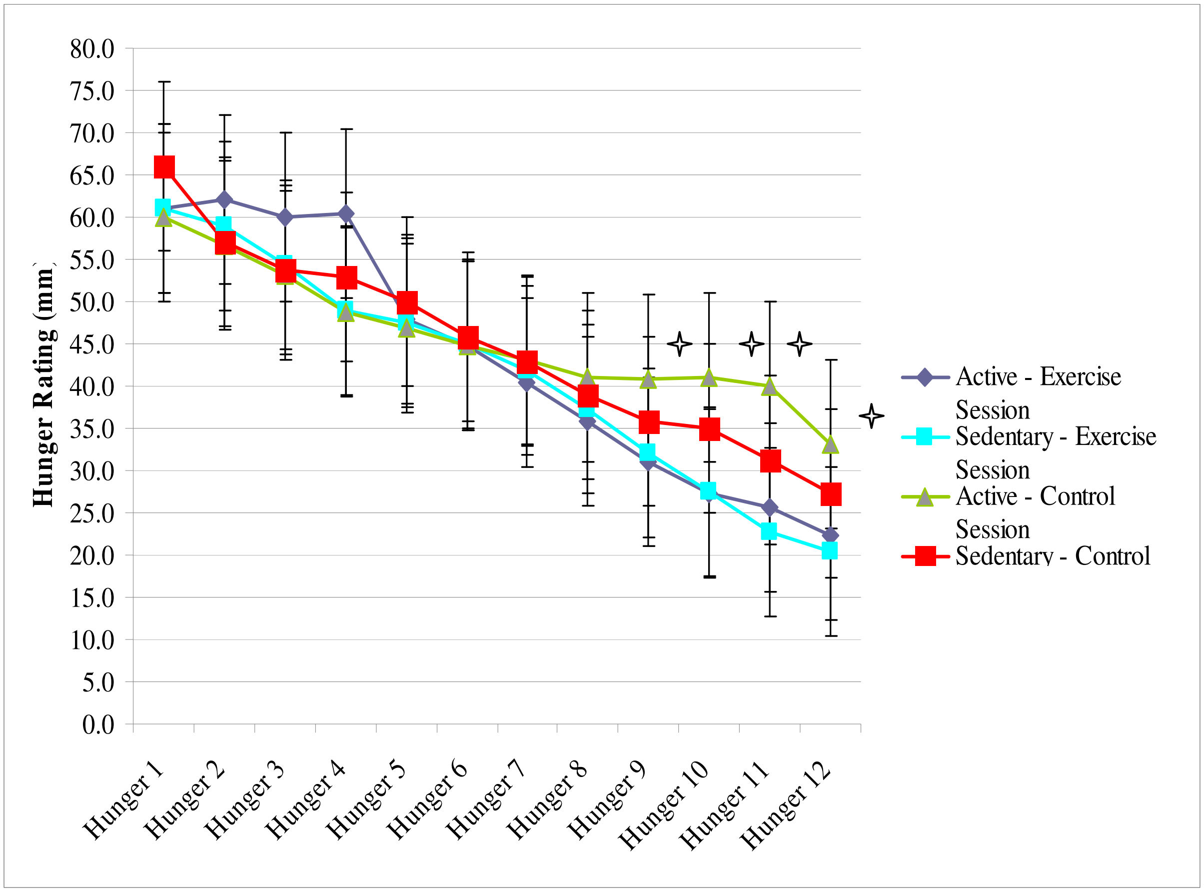


Figure 4: Session hunger ratings prior to the meals*

✧ Significant three way interaction of group (habitually active vs. sedentary), session (exercise vs. control), and time (hunger ratings 1 to 12) for ratings 9, 10, 11, and 12 ($p < 0.05$)

Table 4: Energy and macronutrient intake after session* (M $\pm$ SD)

| | | Habitually Active | Sedentary |
|---|---|---|---|
| Energy Intake (kcal) | Exercise | 1133.8 $\pm$ 498.5$^{a}$ | 1781.3 $\pm$ 632.0$^{a}$ |
| | Control | 1084.6 $\pm$ 755.4$^{b}$ | 1627.6 $\pm$ 421.2$^{b}$ |
| Carbohydrates (% energy) | Exercise | 44.8 $\pm$ 14.0 | 45.2 $\pm$ 11.9 |
| | Control | 40.0 $\pm$ 13.9 | 44.9 $\pm$ 11.3 |
| Protein (% energy) | Exercise | 21.5 $\pm$ 8.4$^{c}$ | 13.7 $\pm$ 5.2$^{d}$ |
| | Control | 23.2 $\pm$ 12.8$^{c}$ | 15.7 $\pm$ 5.3$^{d}$ |
| Fat (% energy) | Exercise | 31.7 $\pm$ 10.7 | 35.4 $\pm$ 12.0 |
| | Control | 34.5 $\pm$ 7.7 | 35.1 $\pm$ 12.7 |

*Means with different superscripts within categories are significantly different ($p < 0.05$).

# **Appendix C: IRB Approved Forms**

# Research Participants Needed!

- Looking for males aged 18-30 years
- Two groups needed:

  -Males who workout no more than 1 hour/week

  -Males who workout at least 30 minutes 5 days/week

- Involves two sessions, each session is about 2.5 hours, with lunch provided!
- Both sessions need to start between 9:30 and 11:30 am on the same day of the week

Each participant will receive $30 upon completion of the study

**Call the Healthy Eating and Activity Laboratory—974-0754**

Exercise and Taste Perception
Research Study
865-974-0754

Exercise and Taste Perception
Research Study
865-974-0754

Exercise and Taste Perception
Research Study
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Exercise and Taste Perception
Research Study
865-974-0754

Exercise and Taste Perception
Research Study
865-974-0754

Phone Script

Hello, this is Emily Jokisch from the Nutrition Department at the University of Tennessee. Let me tell you a little about the study you are calling about. The purpose of the study is to examine your liking of foods after exercise. During the study you will be asked to come to 2, approximately 2.5 hour sessions, scheduled at the same time on the same day of the week within a month of each other, with those sessions starting between 9:30 and 11:30 am. In those sessions you will be either completing an exercise session, in which you will be exercising for about 40 minutes, and a read/homework session, in which you will be asked to read or work on your homework for 45 minutes, and in both sessions you will also rate your hunger and liking of foods, write down what you have eaten and drank the morning before the session, eat a lunch buffet full of a variety of foods, and write down what you eat for the rest of the day following the session. You will be compensated $30 at the end of the second session for participating in this study. If you are interested in the study and have some time (about 10 minutes), I have some questions to ask you to make sure you are eligible for the study.

Go to screening form.

Name:_______________________________

Phone#:______________________________

Subject #:_____________________________

Name:_______________________________

Phone#:______________________________

Subject #:_____________________________

Name:_______________________________

Phone#:______________________________

Subject #:_____________________________

Name:_______________________________

Phone#:______________________________

Subject #:_____________________________

Name:_______________________________

Phone#:______________________________

Subject #:_____________________________

Subject#:_________________

Age:________ (**18-30**) Sex: M F

Height:_______________ Weight:________________
**(BMI 20-24.9)**

Which of the following best describes your racial heritage? (you may choose more than one)

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific islander
- ☐ White
- ☐ Other ______________________________

Which of the following best describes your ethnic heritage?

- ☐ Hispanic or Latino
- ☐ Not Hispanic or Latino

Has your weight been stable over the past 6 months? Y N

Do you have a medical condition(s) that affects your eating (e.g., diabetes, substance abuse, eating disorder, etc.)? Y N

If yes, please describe the medical condition(s)________________________________

______________________________________________________________________

______________________________________________________________________

Do you take medication(s)? Y N

If yes, please describe the medication(s)_____________________________________

______________________________________________________________________

______________________________________________________________________

Do you follow a special therapeutic diet? Y N

If yes, please describe the diet_____________________________________________

______________________________________________________________________

____________________________________________________________________

Do you have a physical or psychiatric diseases (i.e. depression or eating disorder)? Y N

If yes, please describe the disease(s)________________________________________

____________________________________________________________________

____________________________________________________________________

Do you smoke? Y N

Do you have food allergies? Y N

If yes please describe the food allergies_____________________________________

____________________________________________________________________

Do you have any health conditions that may affect your ability to engage in physical activity?

Y N

If yes, please describe the health condition___________________________________

____________________________________________________________________

Do you have any health conditions that may require dietary restrictions? Y N

If yes, please describe health condition______________________________________

____________________________________________________________________

How often do you participate in moderate-intense exercise (i.e., breathing increased, heart rate elevated – similar to brisk walking/jogging) in a week __________________? How many minutes do you spend exercising when you do exercise_________________? (**must be at least 5x for 30 min or less than 1x for an hour**)

Has this regimen been consistent over the past month? Y N

Are you currently dieting to lose weight? Y N

Rate, using a scale from 1 to 5, with 1 being extremely dislike and 5 being extremely like, how much do you like (**must be 3 or higher**):

| | | | | | | |
|---|---|---|---|---|---|---|
| Turkey or Roast Beef sandwich (i.e., mustard, mayo, lettuce, and tomato) | 1 | 2 | 3 | 4 | 5 | |
| Oranges | 1 | 2 | 3 | 4 | 5 | |
| Apples | 1 | 2 | 3 | 4 | 5 | |
| Carrots | 1 | 2 | 3 | 4 | 5 | |
| Pretzels | 1 | 2 | 3 | 4 | 5 | |
| Nacho Cheese Doritos | 1 | 2 | 3 | 4 | 5 | |
| Fudge Swirl Ice Cream | 1 | 2 | 3 | 4 | 5 | |
| Hershey Candy Bar | 1 | 2 | 3 | 4 | 5 | |

Would you be willing to eat:

| | | | | | |
|---|---|---|---|---|---|
| Turkey or Roast Beef sandwich (i.e., mustard, mayo, lettuce, and tomato) | | Y | N | | |
| Oranges | | | Y | N | |
| Apples | | | | Y | N |
| Carrots | | | | Y | N |
| Pretzels | | | Y | N | |
| Nacho Cheese Doritos | | Y | N | | |
| Fudge Swirl Ice Cream | Y | N | | | |
| Hershey Candy Bar | | Y | N | | |

Please answer true or false to the following statements. (**score of 13 and higher – ineligible**)

| | | | |
|---|---|---|---|
| 1) | When I have eaten my quota of calories, I am usually good about not eating any more. | **T** | F |
| 2) | I deliberately take small helpings as a means of controlling my weight. | **T** | F |
| 3) | Life is too short to worry about dieting. | T | **F** |

| | | | |
|---|---|---|---|
| 4) | I have a pretty good idea of the number of calories in common food. | **T** | F |
| 5) | While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. | **T** | F |
| 6) | I enjoy eating too much to spoil it by counting calories or watching my weight. | T | **F** |
| 7) | I often stop eating when I am not really full as a conscious mean of limiting the amount that I eat. | **T** | F |
| 8) | I consciously hold back at meals in order not to gain weight. | **T** | F |
| 9) | I eat anything I want, any time I want. | T | **F** |
| 10) | I count calories as a conscious means of controlling my weight. | **T** | F |
| 11) | I do not eat some foods because they make me fat. | **T** | F |
| 12) | I pay a great deal of attention to changes in my figure. | **T** | F |

Please answer the following questions with one of the responses that is appropriate for you.

1) How often are you dieting in a conscious effort to control your weight?

| | | | |
|---|---|---|---|
| Rarely | Sometimes | **Usually** | **Always** |

2) Would a weight fluctuation of 5 lbs affect the way you live your life?

| | | | |
|---|---|---|---|
| Not at all | Slightly | **Moderately** | **Very Much** |

3) Do your feelings of guilt about overeating help you to control your food intake?

| | | | |
|---|---|---|---|
| Never | Rarely | **Often** | **Always** |

4) How conscious are you of what you are eating?

| | | | |
|---|---|---|---|
| Not at all | Slightly | **Moderately** | **Extremely** |

5) How frequently do you avoid “stocking up” on tempting foods?

| | | | |
|---|---|---|---|
| Almost never | Seldom | **Usually** | **Almost always** |

6) How likely are you to shop for low calorie foods?

Unlikely Slightly unlikely **Moderately likely** **Very likely**

7) How likely are you to consciously eat slowly in order to cut down on how much you eat?

Unlikely Slightly likely **Moderately likely** **Very likely**

8) How likely are you to consciously eat less than you want?

Unlikely Slightly likely **Moderately likely** **Very likely**

9) On a scale from 0-5, where 0 means no restraint in eating (eating whatever you want, whenever you want) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

0 – eat whatever you want, whenever you want

1 – usually eat whatever you want, whenever you want

2 – often eat whatever you want, whenever you want

**3 – often limit food intake, but often "give in"**

**4 – usually limit food intake, rarely "give in"**

**5 – constantly limiting foods intake, never "giving in"**

Where did you see our flyer/advertisement?___________________________________

Confirm availability between 9:30 – 11:30 a.m. on Monday thru Friday and be able to attend two sessions within a month time.

If yes - schedule sessions

**Please eat in your usual manner before coming to the session. Eat something 1.5 to 3 hours prior to your session. Provide directions to building**

**Procedures for Exercise Session**

Prior to session prepare for each participant:
Consent forms (2) – For first session only
Height, Weight, % BF, and BMI form
Hunger VAS (13 – 5 for during exercise, 7 for during rest, and 1 for after the meal)
Liking VAS
7-day Physical Activity Recall
Dietary Intake in-session form
Food record form to take home
Two-dimensional portion aid form (?)
Self-addressed stamp envelope
Gift certificate (if last session)
Buffet food
Food weight form (before and after)
Water weight form (before and after)
Drinking cup
Water (weighed and measured water bottle)
Towel

1) Calibrate scales (directions)
   - Use a standard weight to make sure the scales are properly calibrated, if not zero them out.
2) Prepare bike (directions)
   - The bike should be properly calibrated. Adjust the seat before the participant starts the exercise session. Resistance should be set at 2 KP. Have the participant start peddling until HR goal is reached and keep them at that rpm according to the screen on the cycle ergometer. Keep them at this pace and heart rate throughout the 45 min session.
3) Set up HR monitor (directions)
   - Just before the participant puts on the heart rate monitor, wet the electrode areas of the strap under running water, and make sure the monitor is not attached. Once wet, attach the monitor to the strap. Have the participant put on the strap, under the shirt, and adjust it so it fits snugly, around the chest just below the chest muscles. Make sure the wet electrode area is against the skin. Place watch on participant's wrist.
   - Measuring Heart Rate: begin with the display that shows time of day. Make sure the watch is on the participant's wrist and press ok (red button). The heart will start blinking and the heart rate should show up within 15 seconds. Press ok button again, this will start the stopwatch, and exercise can begin.
   - Stop measuring: Once exercise session is completed, press the stop button (bottom left), which will stop the stop watch. Press again to stop measuring heart rate.
4) Set up TV and DVD's
5) Inform the participant about what will happen during the day's session.

   "We are going to start today by going over what you will be doing today in the study. First, I will pass out the consent forms (if this is their first session), which you must read and sign if you decide you want to participate in the study. If you have any questions as you read through the consent, just let me know and I will answer all of your questions. If you decide to participate in the study, you will sign two copies of the consent form; one copy will be for you to keep and the other will be for our records. After signing the consent form, we will get your height, weight, and percent body fat. After that, you will be asked to participate in the exercise session which will consist of riding an exercise Egrometer for 45 min. During this, your heart rate will be monitored and assessed every 5 minutes. Also assessed during this time will be a hunger rating taken every 10 minutes. Following the exercise part of the session, you have a 60 minute break. During this time you will continue to rate your hunger every ten minutes. You will also fill out two assessment forms during this break and then complete the 60 minutes by reading or doing homework. At the completion of the 60 minute break, you will be asked to eat a supplied buffet. You will be allowed to eat as much or as little of any combination of the food items, and you will want to eat to satisfaction. You will have 25 minutes to eat the meal. After completion of the meal, you will report your liking of foods and your hunger again and be given a food diary with a self addressed envelope for you to send in upon completion. You will be compensated $30 for participating in the study."

**If this is the participants first session:** Pass out two copies of consent form. Instruct participants to initial each page of the consent form as they read it. As you collect 1 copy of consent, ask participants if they have any questions about the study. Make sure researcher and participants sign all consent forms and that pages are initialed.

6) Pass out hunger VAS and instruct participants to mark with a line or x how hungry they are and record hours since last ate. Ask participant if they ate breakfast and to briefly describe what they ate. If participant has not eaten breakfast, or if the breakfast consumed was very different than their usual breakfast, reschedule the session.

7) Measure the participant's height, weight, and body composition and record it on the appropriate form, make sure they still qualify for the study.

8) Set up the participants with the heart rate monitor. Program the wrist band to the appropriate settings. Wet the chest strap and place it on the participant, underneath the shirt. Place on the wrist band and have them hold their wrist next to their chest until the heart rate monitor starts working. Record resting heart rate.

9) Set up the cycle Egrometer for the appropriate settings. Make sure the participants will engage in physical activity at an intensity that is 65-75% of their maximum heart rate (using the formula for heart rate of 220 minus the subject's age), and that will produce a caloric expenditure of approximately 450 kilocalories. To achieve this, participants will ride a cycle ergometer, with resistance set at 2 KP for 45 minutes, and wear a heart rate monitor while they are riding the cycle ergometer. Keep track of exact time and work load on appropriate forms. The calculation for heart rate should have been done before hand. Place the participant on the cycle Egrometer. Inform the participant of their choice of movies to watch and set up that movie on the TV. Supply them with the pre-measured water bottle. While the participant is on the cycle egrometer monitor their heart rate every 5 min. Work will have to be increased or decreased if heart rate is too low or too high,

respectively. Monitor hunger, using the VAS, every 10 minutes throughout the 45 minutes as well. Have the participant point to on the VAS where they feel and then mark that place.

10) Upon completion of the exercise portion of the session, provide the participant with a towel and water, and direct them to the seating area, where they will do the 60 minute resting part of the session. During this time you will continue to rate their hunger every 10 minutes, and complete a record of what they have consumed in the morning prior to the session. Reiterate the importance of making sure they eat that consistent breakfast for both sessions. Once the food dairy is completed – review it with participant to make sure detailed intake information has been obtained (i.e., portion size, food preparation method, etc.) record is completed, assess their recent physical activity using the 7-day physical activity recall. Once these are completed, instruct the participant they can sit and read or do homework for the remaining part of the 60 minutes. Record the amount of water the participant intakes during this break and during exercise.

11) Once the 60 minute session is completed, bring the participant to the kitchen where the food for the buffet will already be prepared. Show them the variety of foods in the ad libitum buffet, and instruct them that they will have 25 minutes to eat, and they should eat to satisfaction.

**12)** After the completion of the 20 minute eating part of the session, assess the participants hunger again and assess the participants liking of foods using VAS. Go through the food record sheet. Explain that they will need to fill out every food or drink item they intake throughout the rest of the day, and explain how to record it on the form. Give them the form, the two-dimensional portion aid form, and the self-addressed and stamped envelope and ask them to mail it in upon completion. **Stress the importance of placing this form in the mail the very next day!!**

13) **If this is their first session:** Confirm their next appointment time, and ask when it would be convenient to give them a reminder call.

14) **If this is their last session:** provide them with their gift certificate and thank them for their participation.

15) Go back to the buffet food and weight and measure each food item and record the amounts left and, therefore, amounts consumed. Clean up all rooms and areas used during the session.

## Procedures for Control Session

Prior to session prepare for each participant:
Consent forms (2) – For first session only
Height, Weight, % BF, and BMI form
Hunger VAS (13 – 5 for during exercise, 7 for during rest, and 1 for after the meal)
Liking VAS
7-day Physical Activity Recall
Dietary Intake in-session form
Food record form to take home
Two-dimensional portion aid form
Self-addressed stamp envelope
Gift certificate (if last session)
Buffet food
Food weight form (before and after)
Water weight form (before and after)
Drinking cup
Water (weighed and measured water bottle)

16) Calibrate scales
  - Use a standard weight to make sure the scales are properly calibrated, if not zero them out.
17) Set up room for resting part of control session with reading materials
18) Inform the participant about what will happen during the day's session.

19) Inform the participant about what will happen during the day's session.

  "We are going to start today by going over what you will be doing today in the study. First, I will pass out the consent forms (if this is their first session), which you must read and sign if you decide you want to participate in the study. If you have any questions as you read through the consent, just let me know and I will answer all of your questions. If you decide to participate in the study, you will sign two copies of the consent form; one copy will be for you to keep and the other will be for our records. After signing the consent form, we will get your height, weight, and percent body fat. After that, you will be asked to participate in the resting session which will consist of sitting and reading or doing homework for 45 minutes. During this time a hunger rating will be taken every 10 minutes. Following the resting part of the session, you have a 60 minute break. During this time you will continue to rate your hunger every 10 minutes. You will also fill out two assessment forms during this break and then complete the 60 minutes by reading or doing homework. At the completion of the 60 minute break, you will be asked to eat a supplied buffet. You will be allowed to eat as much or as little of any combination of the food items, and you will want to eat to satisfaction. You will have 25 minutes to eat the meal. After completion of the meal, you will report your liking of foods and your hunger again and be given a food diary with a self addressed envelope for you to send in upon completion. You will be compensated $30 for participating in the study at the end of your second session."

**If this is the participants first session:** Pass out two copies of consent form. Instruct participants to initial each page of the consent form as they read it. As you collect 1 copy of consent, ask participants if they have any questions about the study. Make sure researcher and participants sign all consent forms and that pages are initialed.

20) Pass out hunger VAS and instruct participants to mark with a line or x how hungry they are and record hours since last ate. Ask participant if they ate breakfast and to briefly describe what they ate. If participant has not eaten breakfast, or if the breakfast consumed was very different than their usual breakfast, reschedule the session.

21) Measure the participant's height, weight, and body composition and record it on the appropriate form, make sure they still qualify for the study.

22) Lead the participant to the room where they will do the control/resting part of the session. Instruct them that they can sit and read or do homework for the 45 minutes. Throughout the 45 minutes, continue to measure their hunger every 10 minutes.

23) Upon completion of the first 45 minutes of the session, another 60 minutes of resting will occur. During this time you will continue to rate your hunger every 10 minutes, and complete a record of what they have consumed in the morning prior to the session. Reiterate the importance of making sure they eat that consistent breakfast for both sessions. Once the food dairy is completed – review it with participant to make sure detailed intake information has been obtained (i.e., portion size, food preparation method, etc.) record is completed, assess their recent physical activity using the 7-day physical activity recall. Once these are completed, instruct the participant they can sit and read or do homework for the remaining part of the 60 minutes.

24) Once the 60 minute session is completed, bring the participant to the kitchen where the food for the buffet will already be prepared. Show them the variety of foods in the ad libitum buffet, and instruct them that they will have 25 minutes to eat, and they should eat to satisfaction.

**25)** After the completion of the 20 minute eating part of the session, assess the participants hunger again and assess the participants liking of foods using VAS. Go through the food record sheet. Explain that they will need to fill out every food or drink item they intake throughout the rest of the day, and explain how to record it on the form. Give them the form, the two-dimensional portion aid form, and the self-addressed and stamped envelope and ask them to mail it in upon completion. **Stress the importance of placing this form in the mail the very next day!!**

26) **If this is their first session:** Confirm their next appointment time, and ask when it would be convenient to give them a reminder call.

27) **If this is their last session:** provide them with their gift certificate and than them for their participation.

28) Go back to the buffet food and weight and measure each food item and record the amounts left and, therefore, amounts consumed. Clean up all rooms and areas used during the session.

Informed Consent Form

**INFORMED CONSENT STATEMENT**
The Effects of Exercise on Taste Perceptions

**INTRODUCTION**

You are being asked to take part in a research study. All research studies carried out at the University of Tennessee are covered by rules of the Federal government as well as rules of the State and the University. Under these rules, the researcher will first explain the study, and then he or she will ask you to participate. You will be asked to sign this agreement which states that the study has been explained, that your questions have been answered, and that you agree to participate.

The researcher will explain the purpose of the study. He or she will explain how the study will be carried out and what you will be expected to do. The researcher will also explain the possible risks and possible benefits of being in the study. You should ask the researcher any questions you have about any of these things before you decide whether you wish to take part in the study. This process is called informed consent.

This form also explains the research study. Please read the form and talk to the researcher about any questions you may have. Then, if you decide to be in the study, please sign and date this form in front of the person who explained the study to you. You will be given a copy of this form to keep.

Participants are invited to participate in a research study in the nutrition department of the University of Tennessee. The purpose of the study will be to look at the differences in liking of foods after an exercise session and after a control session. Emily Jokisch, a graduate nutrition student at the University of Tennessee, advised by Dr. Hollie Raynor, an Assistant professor in the Nutrition Department at the University of Tennessee, is conducting the study. A total of 20 people will participate in the study, and you are being asked to participate in the study because you are a male between the ages of 18 and 30, and your weight is within a healthy weight range.

**INFORMATION ABOUT PARTICIPANTS' INVOLVEMENT IN THE STUDY**

Each participant will come in for an initial session in the morning, between 9:30 and 11:30 am. You will be instructed to eat prior to coming to the session in your usual manner, and to eat a consistent breakfast prior to both sessions. If you do not eat breakfast prior to the sessions or if you do not eat a consistent breakfast the session will be rescheduled. In the first session, your height, weight, and percent body fat will be measured to ensure your eligibility to continue to participate in the study. Each participant will participate in two study sessions, an exercise session and a non-exercise session.

For the exercise session, you will be asked to engage in physical activity at an intensity that is 70% of your maximum heart rate. You will be asked to ride a stationary bicycle for 45 minutes, with the resistance on the bicycle set at 1 kg. While you ride the bike, you will wear a heart rate monitor. Your heart rate will be checked every 5 minutes during the 45 minutes if cycling to make sure you heart rate is at 70% of your maximum rate. During the session, you will be rating their hunger every 10 minutes.

Following the exercise, you will have a 60 minute break. During this time, you will continue to rate your hunger every 10 minutes, and complete a record of what you have consumed in the morning prior to the session. Your recent physical activity will also be measured, in which you will be asked to recall activities you have done over the past 7 days. At the completion of 60 minutes, you will be given a lunch buffet to eat (i.e., sandwiches, fruit, ice cream) and be asked to eat until you are satisfied. You will be given 25 minutes to eat lunch. Upon completion of the meal, you will rate your hunger again, report your liking of the foods you ate in the meal, and be instructed on how to complete a food diary for writing down what you eat during the remaining part of the day. You will be given a self-addressed, stamped envelope so that you can mail the diary back the next day.

The non-exercise session will occur on the same day and time as the exercise session, and in that session you will be asked to sit and read or do homework for 45 minutes. As in the exercise session, you will rate your hunger using the same procedures. Following the 45 minutes of reading/doing homework, you will have a 60 minute break and follow the same procedures as the exercise session.

Following completion of both sessions, you will be provided with $30 compensation.

For this study you will participate in two, approximately 2.5 hour, sessions. These sessions must be completed on the same day of the week, at the same time, within a one month period.

**RISKS**

Participants are at minimal risk in the study. There is the potential for a participant to get injured during the exercise session. However, all participants who are not capable of engaging in the exercise session are not eligible for the study. Another possible risk is being allergic to foods used in the study. However, participants who have reported being allergic to any foods used in the study are not eligible for the study.

**BENEFITS**

There are no specific study-related benefits to participants. Potential benefits of this study are in aiding research by getting information about the relationship between exercise and eating behaviors.

**CONFIDENTIALITY**

Information in the study records will be kept confidential. Data will be stored securely in locked file cabinets and on pass-word protected computer files in Room 102 in the Jessie Harris Building. Data will be made available only to persons conducting the study unless participants specifically give permission in writing to do otherwise. No reference will be made in oral or written reports which could link participants to the study.

**COMPENSATION**

Upon completion of both sessions, you will receive a $30 compensation. Participants will not be eligible for this compensation if they are found not to qualify for the study during the first session, or if they withdraw from the study before completing both sessions.

**EMERGENCY MEDICAL TREATMENT**

The University of Tennessee does not "automatically" reimburse subjects for medical claims or other compensation. If physical injury is suffered in the course of research, or for more information, please notify the investigator in charge, Emily Jokisch at (865) 974-0754.

**CONTACT INFORMATION**

If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact the researcher, Emily Jokisch, at Healthy Eating and Activity Laboratory, 102 Jessie Harris Building, 1215 W. Cumberland Avenue, and (865) 974-0754. If you have questions about your rights as a participant, contact the Office of Research Compliance Officer, Brenda Lawson, at (865) 974-3466.

**PARTICIPATION**

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed you data will be returned to you or destroyed.

## CONSENT

I have read the above information. I have received a copy of this form. I agree to participate in this study.

Participant's signature ______________________________ Date __________

Investigator's signature ______________________________ Date __________

APPROVED

By

JUL 1 7 2008

__________ ~~Participant's initials~~

| Office Use Only | |
|---|---|
| Reference #: | |
| Assessment #: | |

DATE ☐☐ / ☐☐ / ☐☐
M M D D Y Y

## Anthropometric Information

Participant ID number: ________________

Height: ____________________________ (inches)

Weight: ____________________________ (lbs)

BMI: _______________________________

% Body Fat: _________________________ (%)

% Body Water: _______________________ (%)

| Office Use Only |
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| Reference #: |
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Session:

In the table below, please write down a description of what you ate and drank since you woke up. In the description, include the time that you started eating and/or drinking each meal or snack, a description of each item that you ate or drank, and the amount of each item that you consumed. Try to be as specific with food names and amounts as possible.

**Example:** At lunch (12:00 pm), Tom ate a turkey sandwich, chips, a soda, and cookies.

| **Meal (B, L, D, S)** | **Time** | **Description of Food and Drink** | **Amount Consumed** |
| --- | --- | --- | --- |
| L | 12:00 pm | Turkey sandwich | |
| | | White bread | 2 slices |
| | | Turkey luncheon meat (Oscar Meyer) | 2 oz (2 slices) |
| | | American cheese | 1 slice |
| | | Mayonnaise - regular | 2 Tbsp |
| | | Lettuce - iceberg | 1 leaf |
| | | Lay's regular potato chips | 1 oz |
| | | Diet coke | 16 oz |
| | | Oreo cookies | 3 |

| Meal | Time | Description of Food and Drink | Amount Consumed |
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M M D D Y Y

Session:

In the table below, please write down a description of what you ate and drank since you left your session today. In the description, include the time that you started eating and/or drinking each meal or snack, a description of each item that you ate or drank, and the amount of each item that you consumed. Try to be as specific with food names and amounts as possible.

**Example:** At lunch (12:00 pm), Tom ate a turkey sandwich, chips, a soda, and cookies.

| **Meal (B, L, D, S)** | **Time** | **Description of Food and Drink** | **Amount Consumed** |
|---|---|---|---|
| L | 12:00 pm | Turkey sandwich | |
| | | White bread | 2 slices |
| | | Turkey luncheon meat (Oscar Meyer) | 2 oz (2 slices) |
| | | American cheese | 1 slice |
| | | Mayonnaise - regular | 2 Tbsp |
| | | Lettuce - iceberg | 1 leaf |
| | | Lay's regular potato chips | 1 oz |
| | | Diet coke | 16 oz |
| | | Oreo cookies | 3 |

| Meal | Time | Description of Food and Drink | Amount Consumed |
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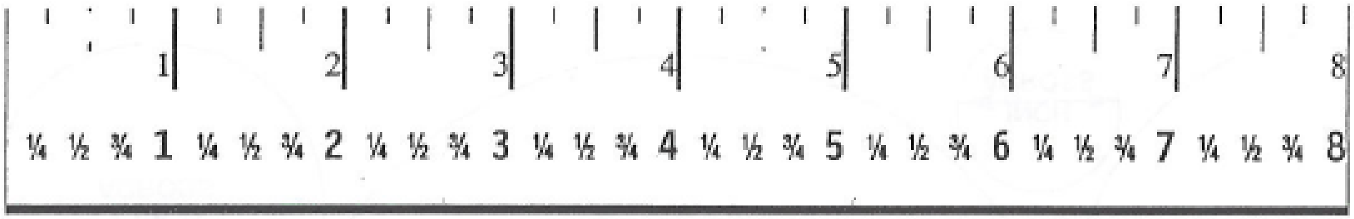
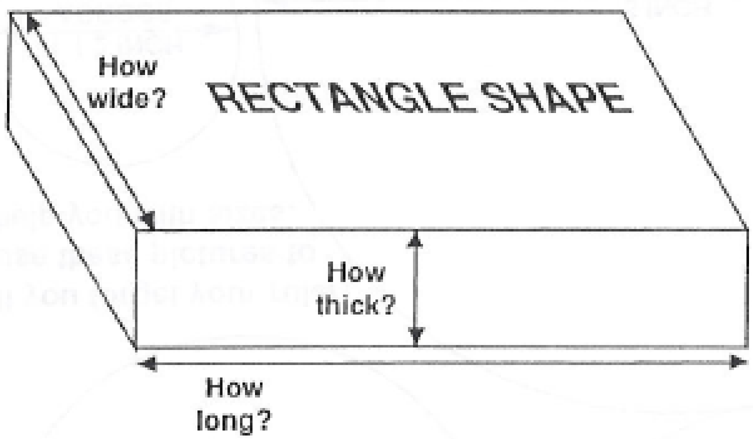
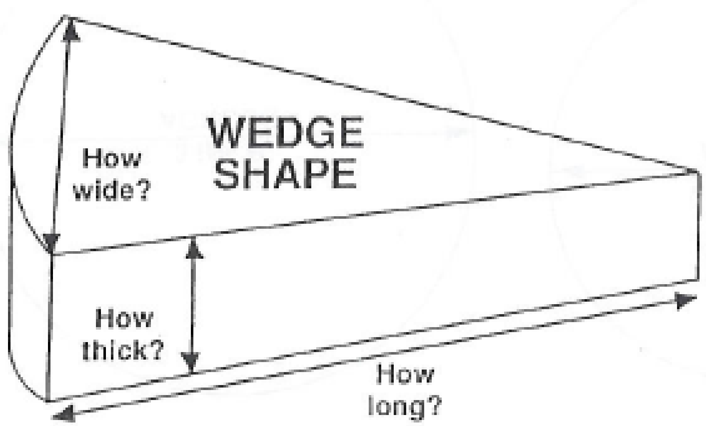
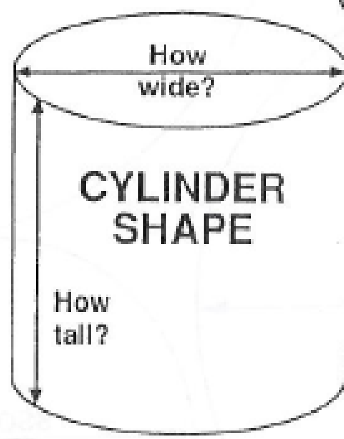


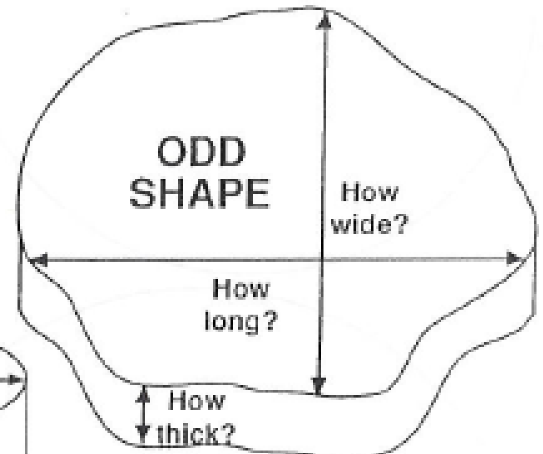

**Measure your food with your ruler, measuring cups or measuring spoons.**

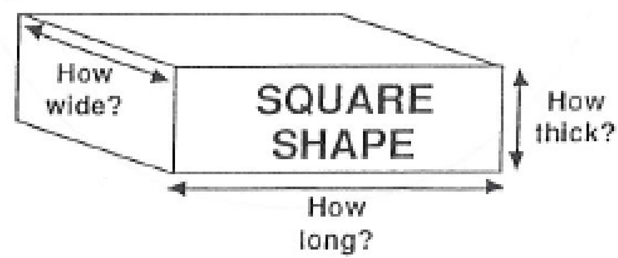
If your food is an odd shape draw a picture of it on the back of your diary page.

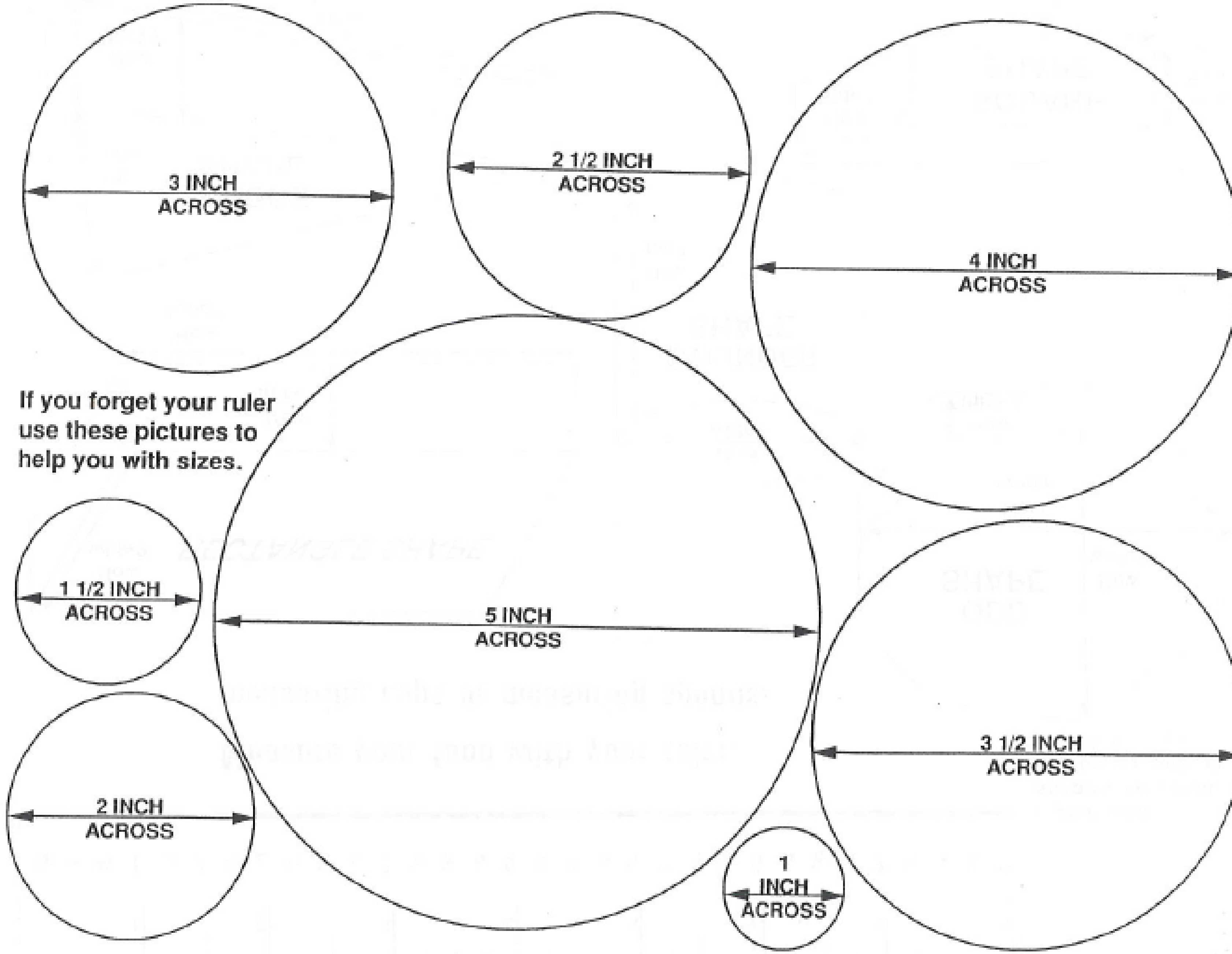


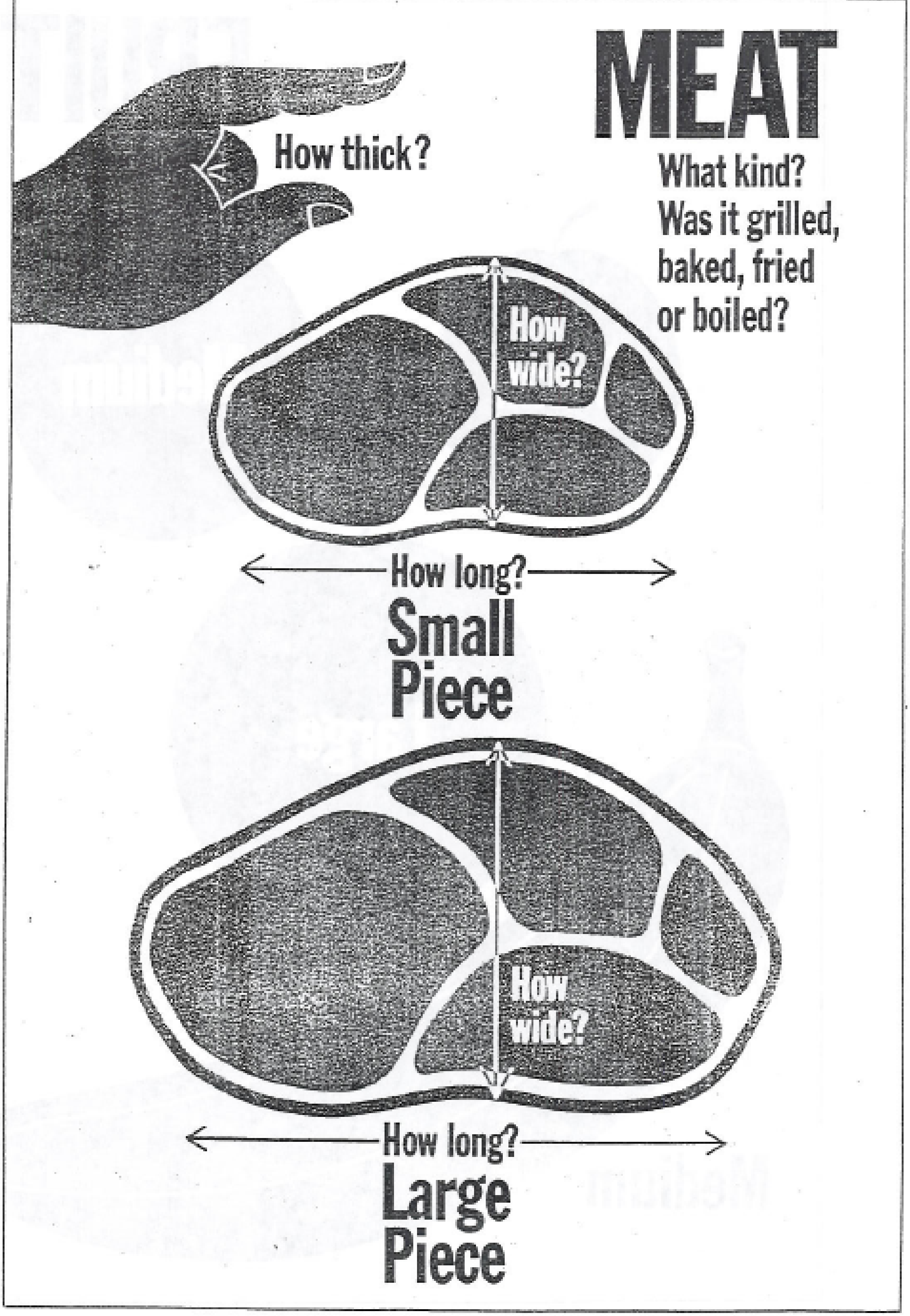



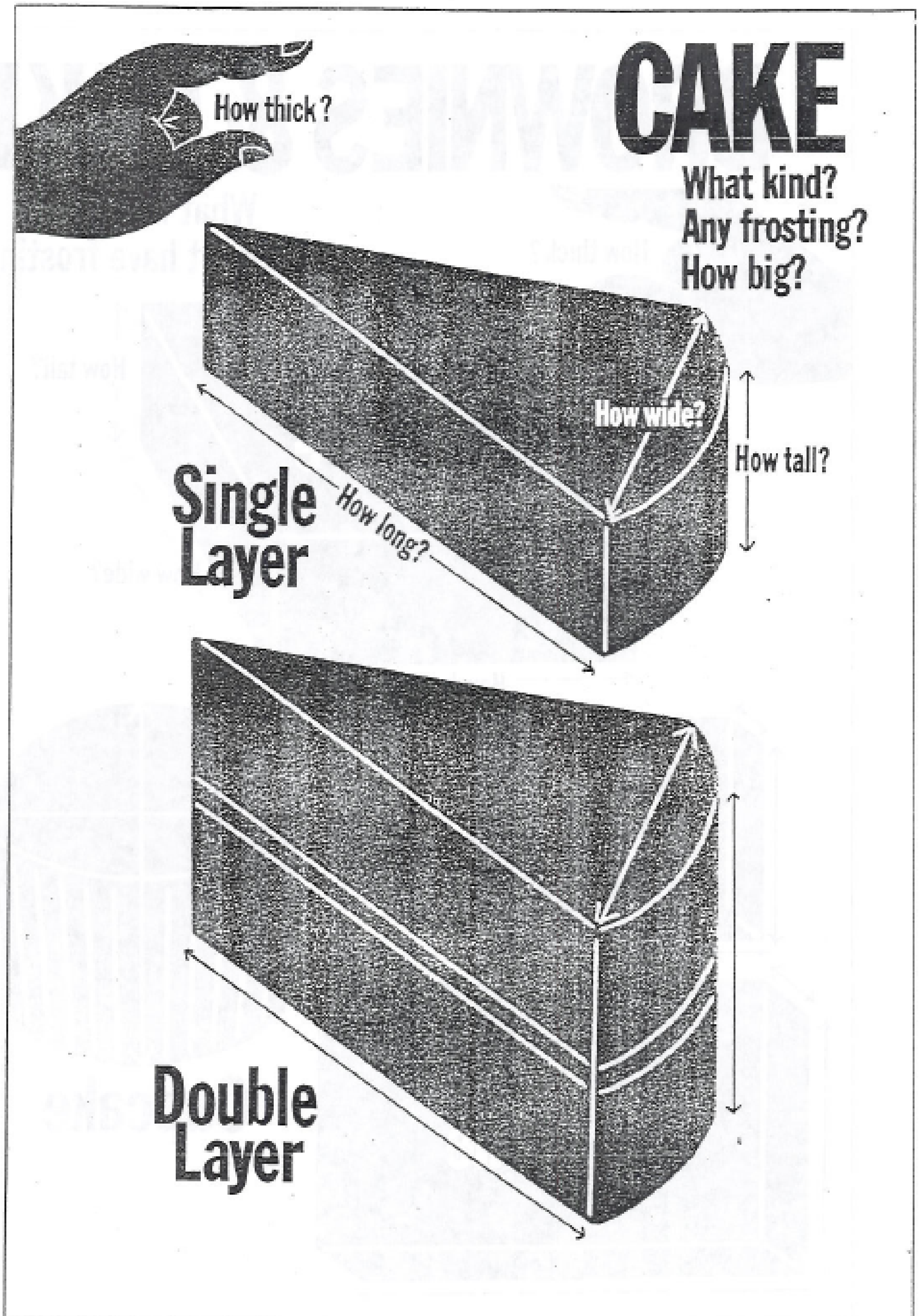



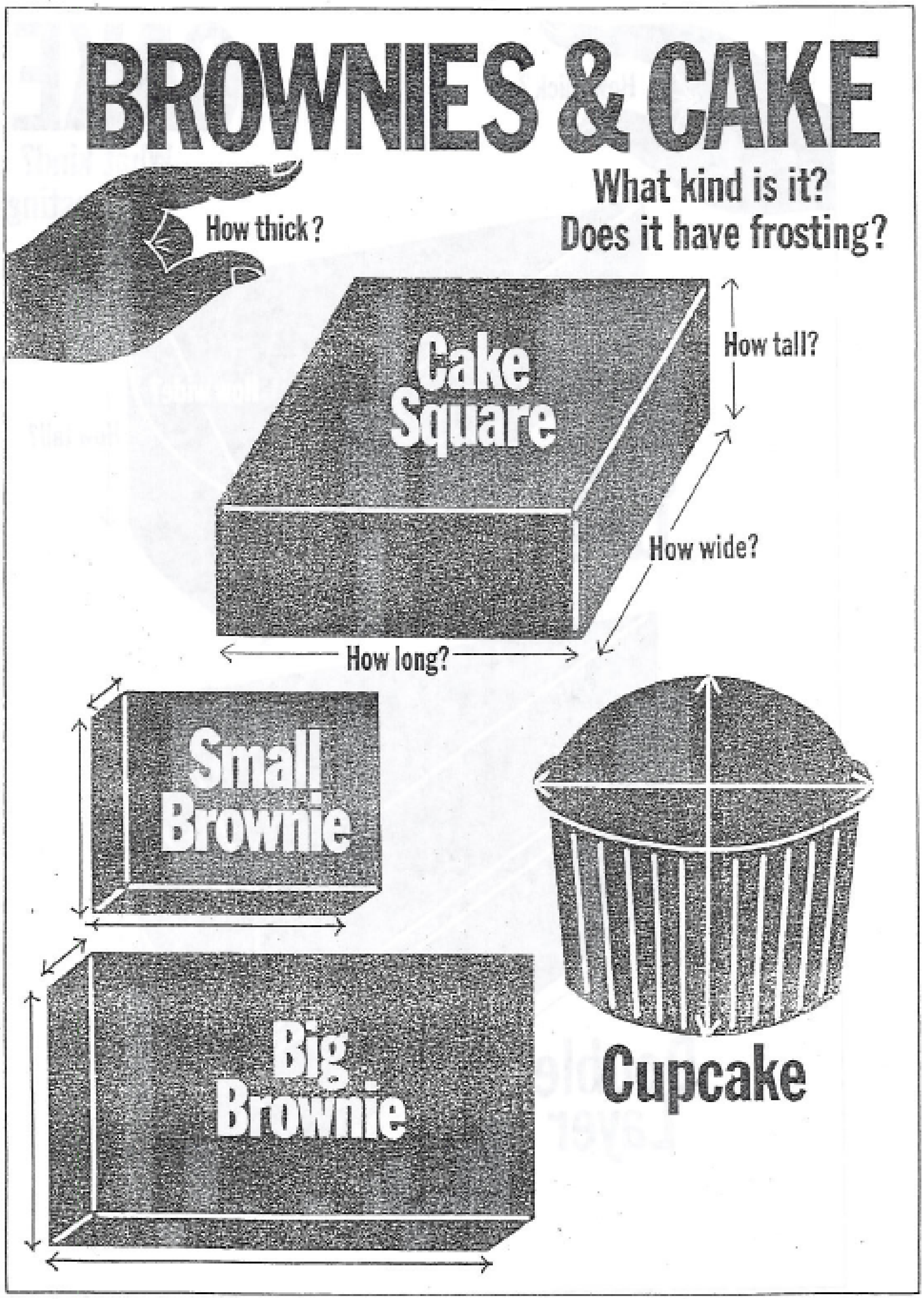


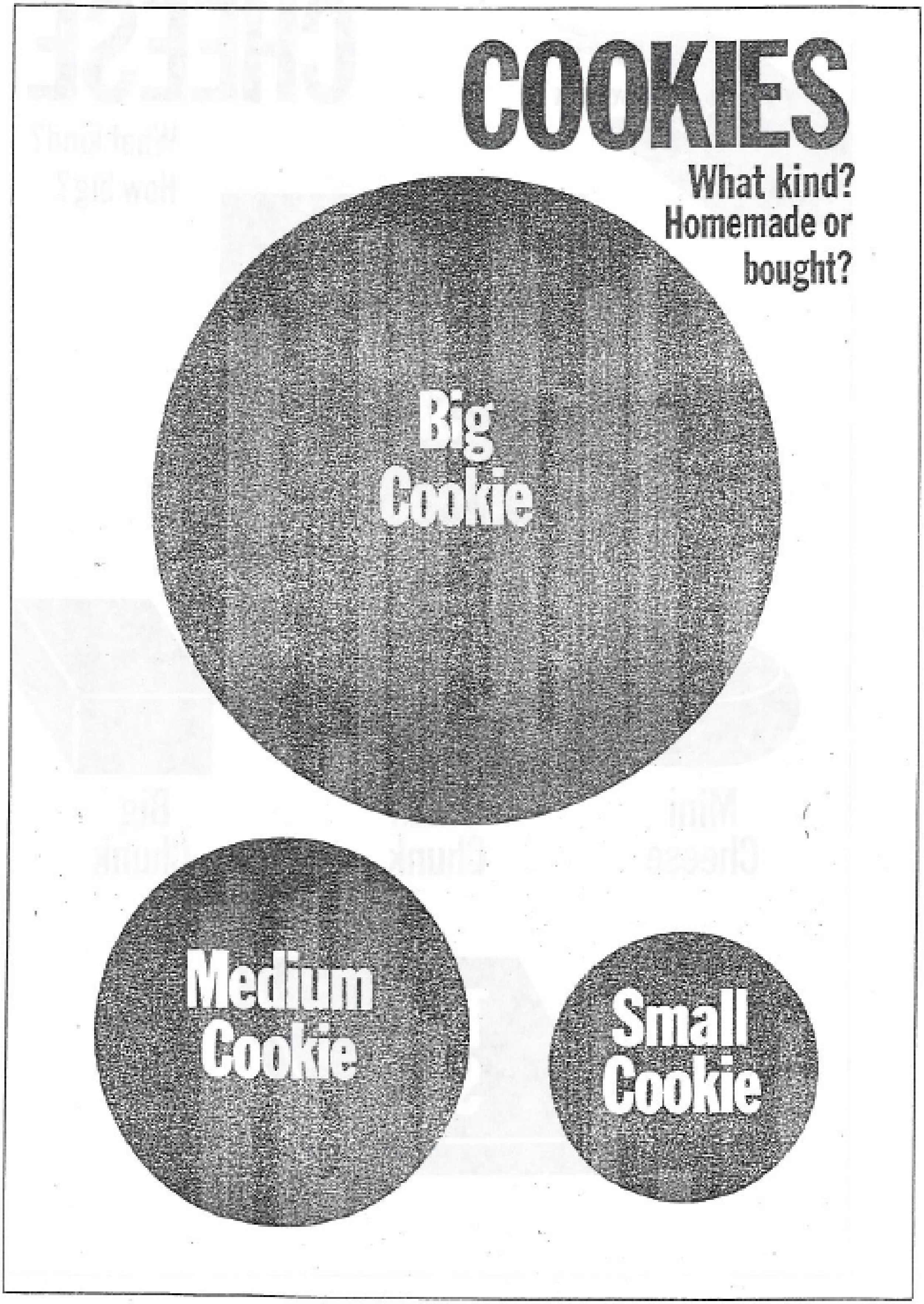

If you forget your ruler use these pictures to help you with sizes.

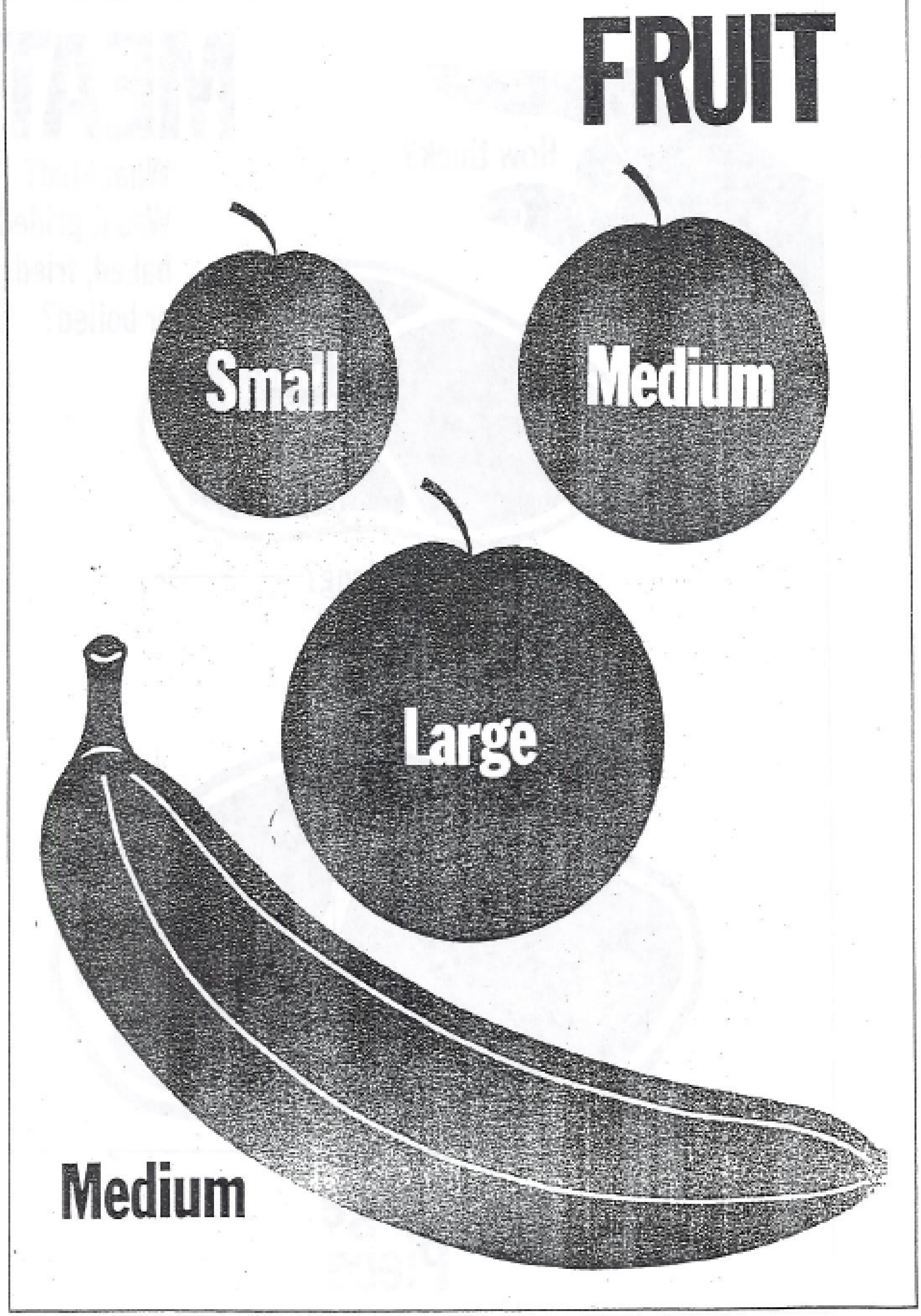

MEAT
What kind?
Was it grilled,
baked, fried
or boiled?
How thick?
How wide?
How long?
Small
Piece
How wide?
How long?
Large
Piece


CHEESE
What kind?
How big?
How thick ?
Thin Slice
Mini Cheese
Small Chunk
Big Chunk
Thick Slice

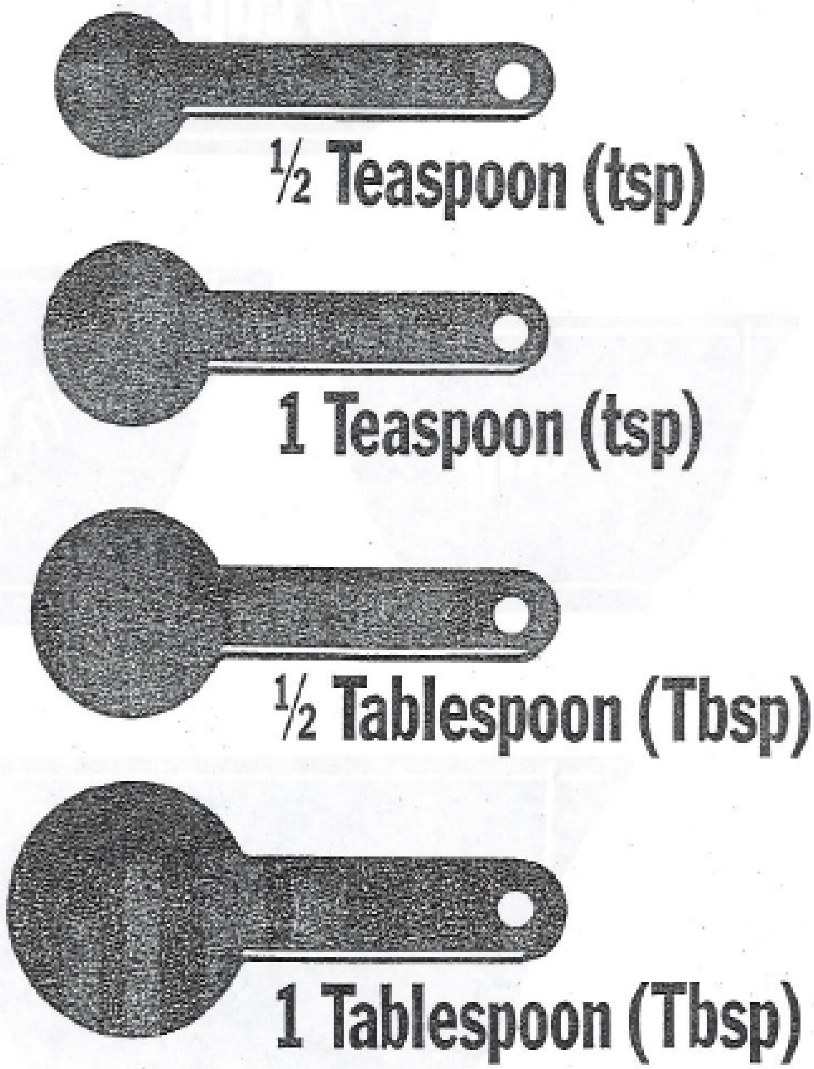

How thick?
CAKE
What kind?
Any frosting?
How big?
How wide?
How tall?
How long?
Single Layer
Double Layer


BROWNIES & CAKE
What kind is it?
Does it have frosting?
How thick?
How tall?
Cake Square
How wide?
How long?
Small Brownie
Big Brownie
Cupcake

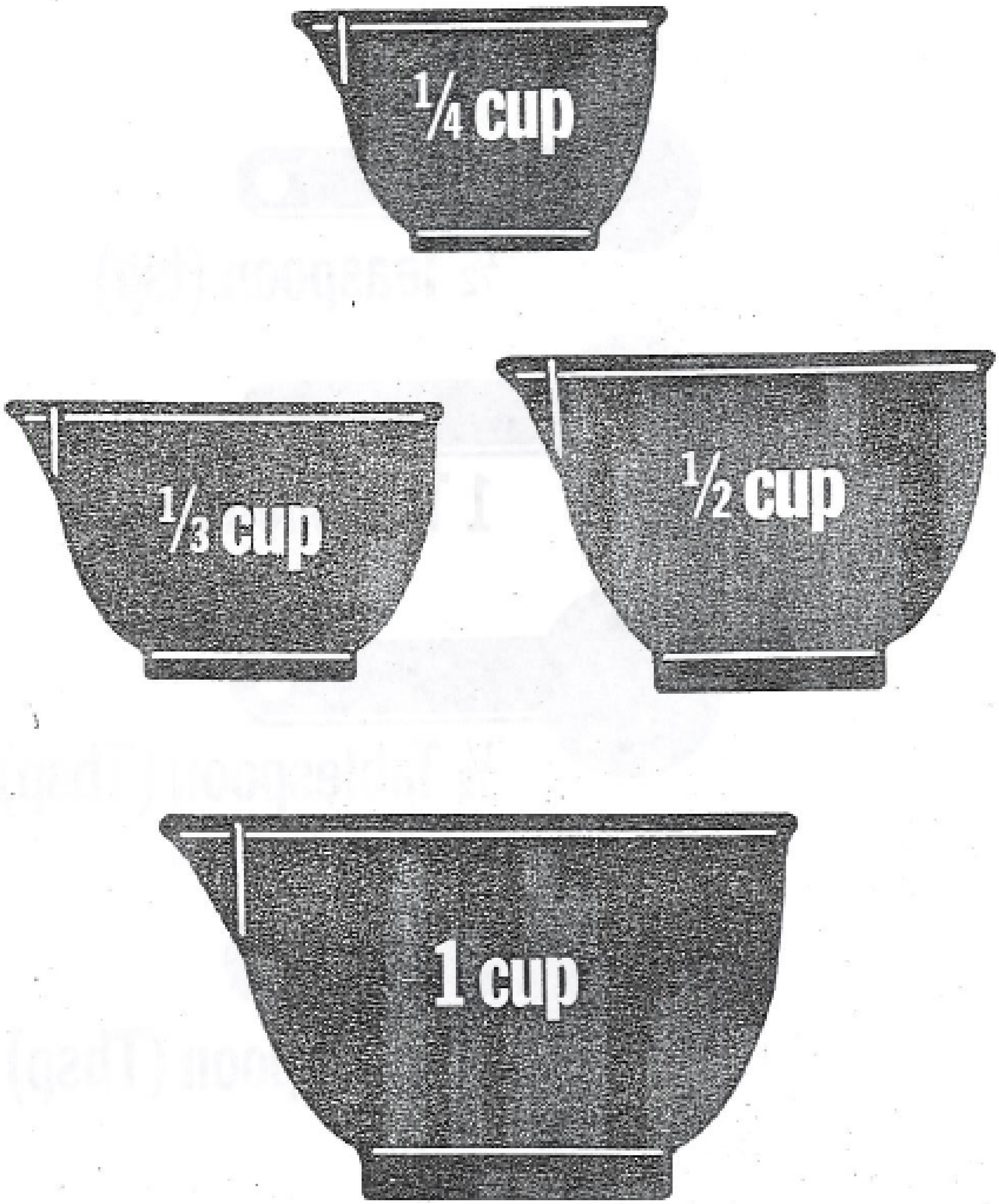

COOKIES
What kind?
Homemade or bought?
Big Cookie
Medium Cookie
Small Cookie


FRUIT
Small
Medium
Large
Medium

Use your measuring spoons for sugar, jelly, margarine, peanut butter, salad dressing, mayonnaise, mustard, catsup



**Use your measuring cups to measure cereal, rice, spaghetti, salad, drinks and anything else**



| Office Use Only | |
|---|---|
| Reference #: | |
| Assessment #: | |

DATE ☐☐ / ☐☐ / ☐☐
M M D D Y Y

## Exercise Statistics

Participant ID number: ____________________________

Bike Resistance: _________________________________ KP

Target Heart Rate: (220-age x .7) ____________________

Rpm:___________________________________________

Actual Heart Rate:
Time 1: _______________________________________
Time 2: _______________________________________
Time 3: _______________________________________
Time 4: _______________________________________
Time 5: _______________________________________
Time 6: _______________________________________
Time 7: _______________________________________
Time 8: _______________________________________
Time 9: _______________________________________
Time 10: ______________________________________

Exercise Time: __________________________________ Min.

Watched Video: Y N

PAR#: 1 2 3 4 5 6 7 Participant________________________________

Interviewer________________Today is__________________ Today's Date______

1. Were you employed in the last seven days? 0. **No** (Skip to **Q#4**) 1. **Yes**
2. How many days of the last seven did you work? ____ days
3. How many total hours did you work in the last seven days? ____ hours last week
4. What two days do you consider your weekend days? ________ ________ (mark days below with a squiggle)

**WORKSHEET** **DAYS**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **SLEEP** | **1** __ | **2** __ | **3** __ | **4** __ | **5** __ | **6** __ | **7** __ |
| **MORNING** | **Moderate** | | | | | | | |
| | **Hard** | | | | | | | |
| | **Very Hard** | | | | | | | |
| **AFTERNOON** | **Moderate** | | | | | | | |
| | **Hard** | | | | | | | |
| | **Very Hard** | | | | | | | |
| **EVENING** | **Moderate** | | | | | | | |
| | **Hard** | | | | | | | |
| | **Very Hard** | | | | | | | |
| **Total Min Per Day** | **Strength:** **Flexibility:** | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

4a. Compared to your physical activity over the past three months, was last week's physical activity more, less or about the same?
1. More
2. Less
3. About the same

**Worksheet Key:** **Rounding:** 10-22 min.=.25 23-37 min.=.50 38-52 min.=.75 53-1:07 hr/min. =1.0 1:08-1:22 hr/min.=1.25

An asterisk (*) denotes a work-related activity.
A squiggly line through a column (day) denotes a weekend day.

No Caption Available.
*From:* Med Sci Sports Exerc, Volume 29(6) Supplement. June 1997.89-103



| Office Use Only | |
|---|---|
| Assessment #: | |
| Reference #: | |

DATE ☐☐ / ☐☐ / ☐☐

M M D D Y Y

## Hunger Scale Visual Analog Scale

On the blank line provided, please draw a vertical line or an 'X' to rate how hungry you are right now. **Also, please cross out and initial any mistakes.**

**EXAMPLE:**

Extremely Hungry Extremely Full

---

Extremely Hungry Extremely Full

Office Use Only:

Score: ___________

| Office Use Only | |
|---|---|
| Reference #: | |
| Assessment #: | |

DATE ☐☐ / ☐☐ / ☐☐
M M D D Y Y

## Hunger Statistics

Participant ID number: ______________________________

Hunger Ratings Scores:

Time 1: __________________________________________

Time 2: __________________________________________

Time 3: __________________________________________

Time 4: __________________________________________

Time 5: __________________________________________

Time 6: __________________________________________

Time 7: __________________________________________

Time 8: __________________________________________

Time 9: __________________________________________

Time 10: _________________________________________

Time 11: _________________________________________

Time 12: _________________________________________

Time 13: _________________________________________

| Office Use Only | |
|---|---|
| Reference #: | |
| Assessment #: | |

DATE ☐☐ / ☐☐ / ☐☐
M M D D Y Y

# Water Weight Form

Participant ID number: ______________________________

| Item | Weight Before | Weight After |
| --- | --- | --- |
| Water: | | |

| Office Use Only | |
| --- | --- |
| Reference #: | |
| Assessment #: | |

DATE ☐☐ / ☐☐ / ☐☐
M M D D Y Y

# Food Weight Form

Participant ID number: ______________________________

| Food Item | Food Weight Before | Food Weight After |
|---|---|---|
| Sandwich | | |
| Orange slices | | |
| Apple Slices | | |
| Carrot Sticks | | |
| Pretzels | | |
| Doritios | | |
| Ice Cream | | |
| Candy Bar | | |
| **Total for meal** | | |

| Office Use Only | |
|---|---|
| Reference #: | |
| Assessment #: | |

DATE ☐☐/☐☐/☐☐
M M D D Y Y

Liking Visual Analogue Scales of Foods

On the blank lines provided, please draw a vertical line or an ‘X’ to indicate how pleasant tasting the following food items are after you sample them. **Also, please cross out and initial any mistakes.**

## EXAMPLE:

Candy

Extremely dislike | Extremely like

---

Office Use Only:

Score: ___________

Food 1:

__ _Sandwich__ _

Extremely dislike | Extremely like

Office Use Only:

Score: ___________

Food 2:

_ _ Orange_ __

Extremely dislike | Extremely like

Office Use Only:

Score: ___________

Food 3:

_____Apple________

Extremely dislike Extremely like

Food 4:

Office Use Only:

Score: ___________

_____Carrot sticks_______

Extremely dislike Extremely like

Food 5:

Office Use Only:

Score: ___________

______Pretzels________

Extremely dislike Extremely like

Office Use Only:

Score: ___________

Food 6:

______Doritos Chips________

Extremely dislike Extremely like

Food 7:

Office Use Only:

Score: ___________

______Ice cream________

Extremely dislike Extremely like

Food 8:

______Hershey Bar______

Office Use Only:

Score: ___________

Extremely dislike Extremely like

## Vita

Emily Jokisch was born in Madison, WI, where she went to high school and graduated with honors. She then went to Barton County Community College where she graduated with high honors with an Associates of Science Degree, and was also named to the deans list. Following this she transferred to The University of Tennessee where she graduated summa cum laude with a Bachelors of Science degree in Nutrition with a minor in Psychology. She stayed at The University of Tennessee for graduate school where she will graduate with a Masters of Science degree in Nutrition with a minor in psychology. During her time in graduate school she was also a teaching assistant for Nutrition 100. Emily has also completed her dietetic internship, and will be taking the Registered Dietitians exam this spring. Currently she works as a clinical dietitian for Parkwest hospital.